NEBRASKA GEOLOGICAL SURVEY

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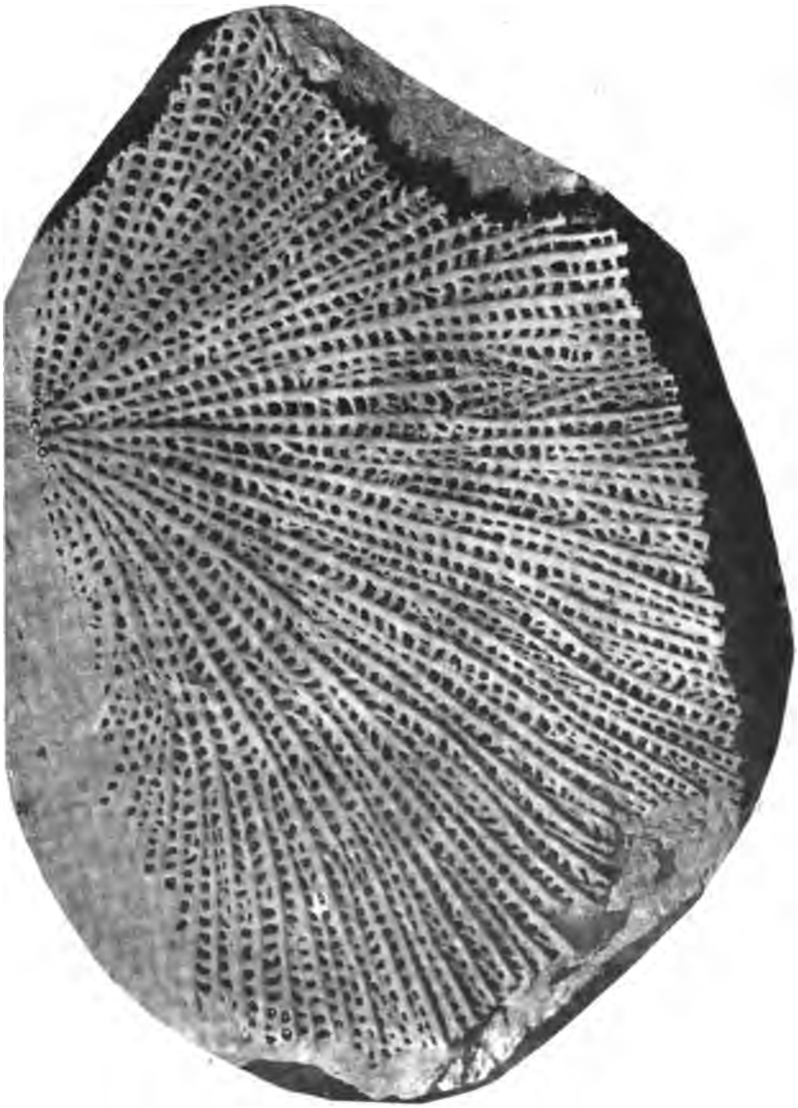

SEPTOPORA BISERIALIS-NERVATA

NEBRASKA GEOLOGICAL SURVEY

ERWIN H. BARBOUR, STATE GEOLOGIST

VOLUME II
PART ONE

THE COAL MEASURE BRYOZOA OF NEBRASKA

BY
GEORGE EVART CONDRA

WITH 21 PLATES

HAMMOND PRINTING CO.,
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WITH THE ASSISTANCE AND COOPERATION OF THE UNITED STATES GEOLOGICAL SURVEY

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LETTER OF TRANSMITTAL

To His Excellency John H. Mickey,
Governor of the State of Nebraska:

SIR:—I have the honor to transmit herewith a manuscript entitled The Coal Measure Bryozoa of Nebraska, prepared by George Evart Condra, Assistant Professor of Geology in the University of Nebraska, it being his thesis for the degree, Doctor of Philosophy.

Very respectfully,
ERWIN HINCKLEY BARBOUR,
State Geologist.

THE UNIVERSITY OF NEBRASKA,
DEPARTMENT OF GEOLOGY,
LINCOLN, JUNE, 1903.

CONTENTS

The Coal Measure Bryozoa of Nebraska

By

George Evart Condra.

INTRODUCTION

In the summer of 1896, at the suggestion of Professor Erwin H. Barbour, Director of The Nebraska Geological Survey, the writer began a study of the fossil bryozoa of the state. Very little was done during the years 1896 and 1897 except to examine literature on the subject and study collections previously secured by the Survey. In order to establish a safe basis for investigation, a large collection of Paleozoic Bryozoa was secured from E. O. Ulrich of Newport, Kentucky, and the study of these specimens was accompanied by a critical examination of all available literature on the subject. Most of the research work was carried on in the laboratories of the University of Nebraska, where a suitable room and necessary equipment were provided.

During the year 1898, and until 1902, collecting trips were made from time to time to all the Coal Measure exposures of Nebraska, which are confined to the south-eastern part of the state. Certain rich localities, as Roca, Bennett, Louisville, Southbend, and Tablerock were visited frequently and worked thoroughly. Owing to the different aspects presented by exposures and quarry strippings under various weather conditions, collecting trips were made during each season of the year. The last visits to the collecting grounds were made primarily for the purpose of extending the vertical and horizontal range of the species. This part of the work should be continued. Since the fossil bryozoa of the state are now

quite well known, a more careful study of their stratigraphic position should be undertaken.

Professor Erwin H. Barbour, Miss Carrie A. Barbour, Messrs. C. A. Fisher, W. H. H. Moore, and E. G. Woodruff have assisted in the collecting. The specimens collected constitute a part of the Morrill Collection in the museum of the University of Nebraska.

To clean the specimens, prepare a sufficient number of microscopic sections for study, and to properly classify the collection, has been a tedious and often a perplexing task. The microscopic mounts were made by the writer and R. S. Bassler of the National Museum, Washington, D. C. The illustrations were drawn by the writer, E. O. Ulrich, Mrs. G. E. Condra, and Miss E. Pearl Hensel. A few figures were drawn from photographs taken by A. Hyatt Verrill of New Haven, Connecticut, and by C. G. Cornell of this Survey, who also made the plates.

On account of their conciseness, diagnoses by Nickles and Bassler in Bulletin 173, U. S. Geological Survey, have been freely used. Bibliographies and other features of that bulletin have greatly facilitated the preparation of this report. Volume VIII, Pt. VI, Geological Survey of Illinois, written by E. O. Ulrich, has proved by far the most valuable reference consulted. Ulrich's system of classification is followed.

The number of species and varieties found is considerably greater than was at first supposed. Yet, the writer believes that if quarries are re-opened and a careful study continued, still other species may be secured. The number of Coal Measure quarries operated in the state within recent years has decreased and some of the exposures visited by Meek in 1867 are now entirely covered by talus.

It is hoped that this report may be used to advantage by students of stratigraphic paleontology, to assist in a more accurate determination of the Coal Measure stratigraphy of the state. No fossils can be better used in such a study, since certain beds of Atchison Shales (Wabaunsee of Prosser) containing large numbers of characteristic bryozoa can be traced for miles at

places, this being especially true with respect to outcrops along the Platte River.

It now remains for the writer to acknowledge his indebtedness to Messrs. E. O. Ulrich and R. S. Bassler for the unselfish assistance they have given in the preparation of this paper. Specimens sent to Mr. Ulrich for verification were returned with valuable notes and suggestions. A few of the species described by the writer in an earlier paper had been previously collected by Mr. Ulrich and were known by him to be new, yet he relinquished his claim to the right of naming them, requesting only that the names Cyclotrypa (?) barberi, and Meekopora prosseri might be recognized. The careful researches and the lucid descriptions of Mr. Ulrich have rendered possible the study of this difficult group of fossils.

Especial thanks and gratitude are due Professor Erwin H Barbour, whose kind and stimulating assistance has made this publication possible. Through him, and by the generous financial support of Hon. Charles H. Morrill, the University places at the disposal of the writer the most ample facilities for the prosecution of the work.

CLASSIFICATION

"The systematic position of the bryozoa has been and is yet a subject of dispute." Until about 1775 they were quite generally regarded as plants, but at that date John Ellis published his "Natural History of the Corallines" which did much to establish the animal nature of bryozoa. Linne believed their affinities were with the plants. As early as 1828 their resemblance to the Ascidiae was observed.

Ehrenberg divided the Polypi into Bryozoa and Anthozoa. About the same time Thompson observed their similarity to the compound Ascidiae and gave them the name Polyzoa, separating Polyzoa from the Corals. The Ascidiae have since been removed from Molluscoidea. "It has been and still is a matter of dispute whether the term Bryozoa of Ehrenberg, or Polyzoa of Thompson has priority." At present, most paleontologists use

the former term and place the bryozoa with that indefinite assemblage of animals, the Molluscoidea.

There is lack of agreement in the arrangement of both the higher and lower groups of bryozoa themselves; especially is this true with the higher groups. Ulrich's system of classification, based in the main on internal microscopic characters, is now quite generally followe l. Most of the earlier paleontologists used external characters in describing species, and, as a result, the identification of a number of their forms is now quite impossible. Later authors have emphasized the microscopic structure, but it is evident that the internal characters are not equally important in all families for the purposes of classification. Of the six families represented in Nebraska, Fistuliporidae, Batostomellidae, and Rhabdomesontidae cannot be studied well without prepared sections, but Fenestellidae, Acanthocladiidae, and Cystodictydae can be classified from external characters alone. Some authors have not sufficiently considered forms and conditions of growth. The temptation to create new species without sufficient data has resulted in the naming of certain forms and varieties as species. "The determination of the exact affinities of bryozoa remains a subject for investigation." Dr. F. W. Sardeson, in the Journal of Geology, Vol. IX, Nos. 1 and 2, 1901, gives rather full argument to show that the Monticuliporoidea are more closely related to the tabulate-corals than to bryozoa.

The following outline of classification shows the Coal Measure bryozoa of Nebraska grouped with the rank of genera and higher:

Subkingdom MOLLUSCOIDEA

Class BRYOZOA Ehrenberg[1]

Group ECTOPROCTA Nitsche[2]

Order GYMNOLAEMATA Allman[3]

Suborder CYCLOSTOMATA Busk[4]

Fam. I. Fistuliporidae Ulrich

Gen. 1. Fistulipora McCoy

Gen. 2. Cyclotrypa Ulrich

Gen. 3. Meekopora Ulrich
Suborder TREPOSTOMATA Ulrich[5]
Fam. II. Batostomellidae Ulrich
Gen. 4. Batostomella Ulrich
Gen. 5. Stenopora Lonsdale
Suborder CRYPTOSTOMATA VINE[6]
Fam. III. Fenestellidae King
Gen. 6. Fenestella Lonsdale
Gen. 7. Polypora McCoy
Gen. 8. Thamniscus King
Fam. IV. Acanthocladiidae Zittel
Gen. 9. Pinnatopora Vine
Gen. 10. Septopora Prout
Fam. V. Rhabdomesontidae Vine
Gen. 11. Rhombopora Meek
Gen. 12. Streblotrypa Ulrich
Fam. VI. Cystodictyonidae Ulrich
Gen. 13. Cystodictya Ulrich

1. 1828-31, Ehrenberg, Symbolae Physicae seu Icones et Descriptione Animalium Evertebratorum.
2. 1869, Nitsche, Zeitschrift für Wissenschaftliche Zoologie, XX.
3. 1856, Allman, Monogr. Freshwater Polyzoa, p. 10.
4. 1852, Busk, Brit. Mus. Cat. Marine Polyzoa.
5. 1882, Ulrich, Jour. Cincinnati Soc. Nat. Hist. V., p. 151.
6. 1883, Vine, Rept. Brit. Assoc. Adv. Sci., p. 196.

One order, three suborders, six families, and thirteen genera have been found in the state. There is some question in regard to the presence of Cyclotrypa. The single species referred to that genus may belong to Fistulipora.

LETTER OF TRANSMITTAL

To His Excellency John H. Mickey,
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SIR:—I have the honor to transmit herewith a manuscript entitled The Coal Measure Bryozoa of Nebraska, prepared by George Evart Condra, Assistant Professor of Geology in the University of Nebraska, it being his thesis for the degree, Doctor of Philosophy.

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ERWIN HINCKLEY BARBOUR,
State Geologist.

THE UNIVERSITY OF NEBRASKA,
DEPARTMENT OF GEOLOGY,
LINCOLN, JUNE, 1903.

LIST OF COAL MEASURE BRYOZOA OF THE UNITED STATES—Continued

SPECIES	Locality	
	Nebraska	Other Localities
Stenopora carbonaria (Worthen)	X	O., Ill., Kans., Mo.
Stenopora carbonaria-conferta Ulrich	X	Ill.
Stenopora carbonaria-maculosa Ulrich	....	Ill.
Stenopora distans Condra	X	....
Stenopora heteropora Condra	X	....
Stenopora ohioensis Foerste	....	O., Kans., Mo.
Stenopora (?) polyspinosa (Prov.) Condra.	X	....
Stenopora signata Ulrich	....	Ill.
Stenopora spinulosa Rogers	X	Kans., Mo.
Stenopora spissa Rogers	....	Kans.
Stenopora tuberculata (Prout)	X	....
Streblotrypa prisca (Gabb and Horn)	X	Kans.
Streblotrypa striatopora Rogers	....	Kans., Mo.
Thamniscus octonarius Ulrich	....	Kans.
Thamniscus palmatus Condra	X	....
Thamniscus pinnatus Condra	X	....
Thamniscus sevillensis Ulrich	X	Ill.
Thamniscus tenuiramus Rogers	....	Kans., Mo.

Careful study may show that a few so-called species in the above list are forms and varieties only. There is some doubt whether the species marked (*) belong to the Coal Measures or to the (Subcarboniferous) Mississippian, below. They were reported from the Carboniferous as follows: White's species, Organ Mountains, New Mexico; Coscinium dictyotum (Meek), Mystic Lake, Montana; Polypora stragula (White), and Pinnatopora nereidis (White), Arizona.

STRATIGRAPHIC DISTRIBUTION

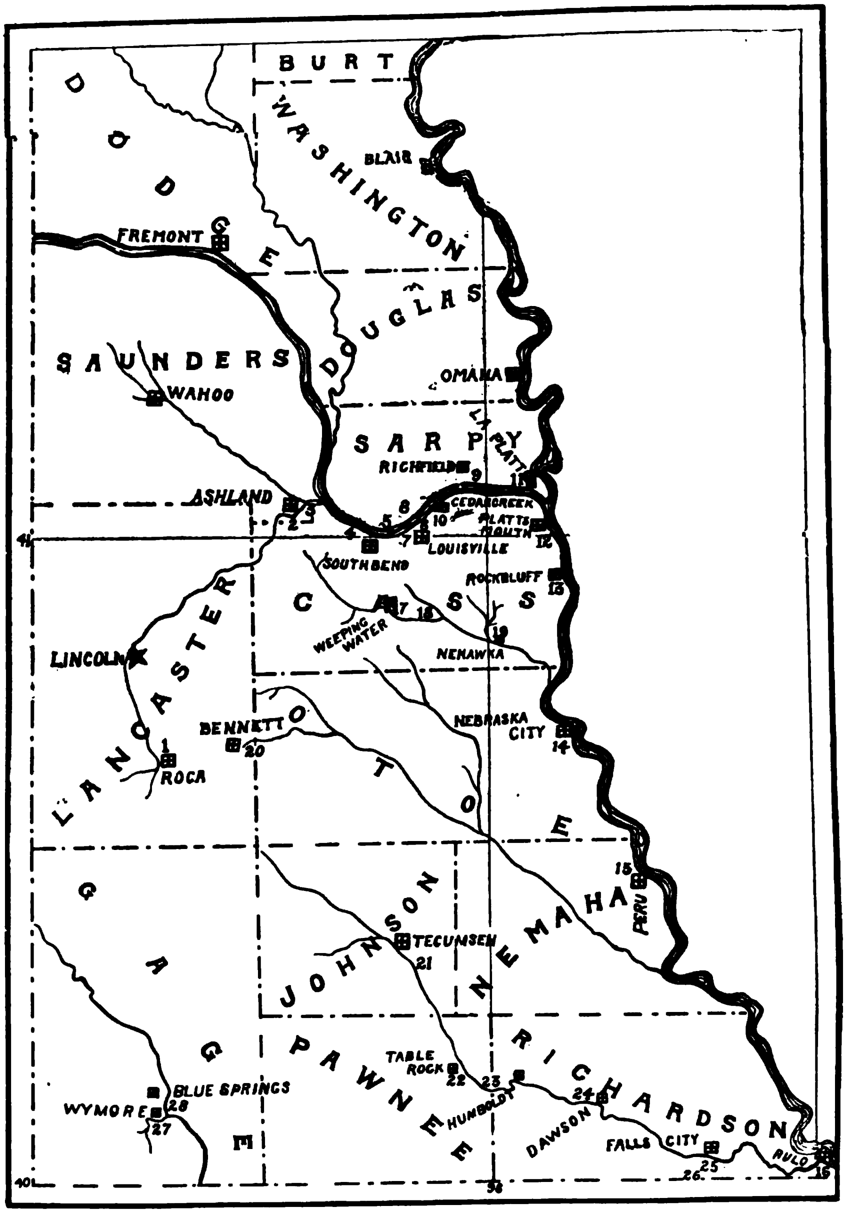
While the conditions for growth and fossilization of bryozoa were not generally the best in the United States and other countries during Coal Measure times, those which prevailed in Nebraska, Kansas and Missouri, being more favorable than elsewhere, have afforded a large number of species. Rogers, in Kansas Uni. Quar., Vol. IX, No. 4, pp. 233-254, reports a large list of species from the Pottawattamie and Douglas formations

of Kansas and Missouri. Species herein described were collected in the main from the Atchison shales, one of the upper divisions of the Missourian or Coal Measures. Prof. Prosser has proposed the name Wabaunsee for most of the same formation. The overlying Cottonwood has thus far afforded only a few fragmentary specimens. The Coal Measure species Rhombopora lepidodendroides Meek, and Polypora elliptica Rogers, extend into the Permian at Blue Springs and Wymore, adding to the already large list of fossils common to the so-called Permian of Nebraska and the Coal Measures. Rogers has collected Streblotrypa prisca (Gabb and Horn) in both the Coal Measures and Permian of Kansas. The stratigraphic position of the Warner quarries near Roca has been a subject of dispute, the exposures there being regarded by some as Permian. The lower beds of the quarries contain a large number of Coal Measure bryozoa, of which Rhombopora lepidodendroides, Streblotrypa prisca, Septopora biserialis and Polypora elliptica, are found in the so-called Permian farther south.

The specimens occur in limestone, shale, and clay. Probably most specimens found on the clay banks of clay pits were originally entombed in either limestone or shale above, and have been loosened by weathering of the beds. This condition is quite apparent at Tablerock, where numerous and usually incomplete Fenestelloids occur scattered over clay banks below limestone ledges. The more perfectly preserved Fenestellae and Septoporae were collected from beds of shale and impure limestone. Many of the best specimens of other genera were found among quarry strippings. The zoaria are usually calcareous, but Cyclotrypa (?) barberi Ulrich, and some Stenoporae at times contain silicious matter.

GEOGRAPHIC DISTRIBUTION

The main Coal Measure exposures of Nebraska are confined to Lancaster, Saunders, Sarpy, Cass, Douglas, Otoe, Johnson, Nemaha, Pawnee, and Richardson counties of the southeastern part of the state. The rock beds of this period have been



MAP SHOWING LOCALITIES WHERE SPECIMENS WERE COLLECTED.

exposed by erosive action of the following rivers and creeks together with their tributaries: Salt, Platte, Missouri, Weeping Water, Little Nemaha, and Nemaha. The streams have cut through Loess, Drift, Cretaceous (where it occurs), and into the Coal Measure beds. The valleys varying considerably in width are bordered by rounded hills or by steep bluffs cut into by numerous tributary streams. The upland country between the hills and bluffs bordering the water-ways is hilly, undulating or quite level, depending for the most part on the amount of dissection by streams.

Salt Creek flows northward past Lincoln and then northeastward by Ashland to the Platte. Throughout most of the valley Coal Measure beds are concealed by Loess, Drift, and Dakota Cretaceous. Localities:

Roca (1).* The Warner quarries, situated about one mile north of the town and eleven miles south of Lincoln, have afforded a large list of species.

Ashland (2). In a drainage channel along the B. & M. railroad and about one-half mile south of the station. (3) About three-quarters of a mile northeast of the B. & M. station and in a small ravine one-fourth of a mile south of the southern end of a deep cut on the Ashland Cut-off line of the B. & M. railroad.

The Platte Valley rapidly narrows below Ashland, where the stream encounters the resistant Coal Measure strata. Bluffs with outcroppings of these beds continue with little interruption from this point to Plattsmouth and beyond. While specimens have been secured from many places along this course of the valley the following localities seem to be the richest in bryozoa:

Southbend (4). Exposures in the bluffs beginning about one mile north of town. The upper beds contain the most fossils. (5) Across the river from Southbend. Specimens found in the quarry south of the east end of the old wagon road bridge and in outcrops in the vicinity of the bridge.

*These numbers refer to localities designated in the map and the table showing the distribution of species.

Louisville (6). Upper beds of the old quarry one-half mile east of the B. & M. station. This is one of the richest and most accessible localities in the state. (7) Quarries one-half mile west of the B. & M. station. The second and third quarries contain the most fossils. (8) In the large quarries and ravines west of the clay pit across the river from Louisville or west of Meadows.

Richfield (9). Quarries near the river about three miles south of town.

Cedarcreek (10). The Atwood quarries along the switch southwest of town.

LaPlatte (11). Most of the specimens were collected from exposures near the northern end of the railroad bridges about one-half mile southwest of the B. & M. station.

The Missouri in the region under consideration is bordered for most of the distance on the Nebraska side by a continuation of the high dissected bluffs observed along the Platte. The principal localities are:

Plattsmouth (12). Exposures both north and south of the western end of the B. & M. railroad bridge.

Rockbluff (13). Exposures near by.

Nebraska City (14). About two miles west. Also in the bluffs and ravines along the river near town. The most fossiliferous beds are Meek's divisions C and B.

Peru (15). Bluffs one-half mile or more north of the railroad station.

Rulo (16). Very few specimens have been collected from exposed beds here. Meek's specimens were secured largely from well-borings.

Weeping Water Creek rises in west-central Cass county and flows south of east, joining the Missouri near Wyoming in the northeastern corner of Otoe county. Localities:

Weeping Water (17). In quarries from one-half to two miles below town. (18). A quarry and outcropping beds north of the railroad and about midway between Weeping Water and Nehawka.

Nehawka (19). Quarries just northeast of town.

The Little Nemaha, heading by different tributaries in Cass, Otoe, and Lancaster counties, flows in a southeasterly directiou, joining the Missouri below Nemaha, in Nemaha county. Several of the exposures along this stream belong to the Cottonwood formation which contains few bryozoa. Locality:

Bennett (20). A place in the creek bed about two miles below town and eighteen miles southeast of Lincoln is rich in bryozoa.

The Nemaha flows through Johnson, Pawnee and Richardson counties to the Missouri. Throughout most of its course the flood plain is wide and the bordering slopes are generally covered with talus. Specimens found in railroad cuts, quarries, and a few cut-banks. Localities:

Tecumseh (21). About two miles below town in a cut on the Kansas City line of the B. & M. railroad.

Tablerock (22). Several species occur in the clay pits near the B. & M. station. (23). Exposures in the hills north of the railroad and about mid-way between Tablerock and Humboldt,

Dawson (24). Railroad cuts west of the B. & M. station.

Falls City (25). Near the mouth of Pony Creek south of town. (26). Exposures southwest of town, and in the Lehmer quarries.

TABLE SHOWING DISTRIBUTION

LOCALITY / SPECIES	Batostomella iela Condra	Cyclotrypa (?) barberi Ulrich	Cystodictya anisopora Condra	Cystodictya lophodes Condra	Cystodictya inequamarginata Rogers	Fenestella binodata Condra	Fenestella conradi Ulrich	Fenestella conradi-compactilis Condra	Fenestella cyclofenestrata Condra	Fenestella gracilis Condra	Fenestella Kansanensis Rogers	Fenestella limbata Foerste	Fenestella mimica Ulrich	Fenestella parvipora Condra	Fenestella perelegans (Meek)	Fenestella polyporoides Condra	Fenestella spinulosa Condra	Fenestella subrudis Condra	Fenestella tenax Ulrich (?)
Roca, (1). Warner quarries north of town..	..	X	X	X	X	X	..	X	..	X	X	..	X	X	X	X	X	..	..
Ashland, (2). South of B & M. station......	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X
Ashland, (3). North of B. & M. station....	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	?
Southbend, (4). Above town	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Southbend, (5). Across the river	X	..	..	..	..	X	X	X	..	..	..	..	..	..	..	..	..	..	X
Louisville, (6). Below town.................	..	X	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Louisville, (7). Above town.................	..	X	X	..	..	X	..	..	..	..	X	..	..	..	..	..	..	..	..
Louisville, (8). Across the river............	..	X	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Richfield, (9). South and east of............	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..	..	..	..	..
Cedarcreek, (10) Atwood quarries S.-W. of	..	X	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..
La Platte, (11). West of town	..	X	..	..	..	..	X	..	..	..	..	..	..	..	..	..	..	..	..
Plattsmouth, (12) Near B. & M. bridge.....	..	X	..	..	..	..	X	..	..	..	X	..	X	..	..	X	..	..	..
Rockbluff, (13)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Nebraska City, (14). West, and bluffs S.-E.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..	..	..
Peru, (15). North of town...................	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rulo, (16). South of town..................	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Weeping Water, (17). Just below town.....	..	X	..	..	..	X	..	X	..	..	..	..	..	..	..	..	..	..	..
Between Weeping Water and Nehawka, (18).	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..
Nehawka, (19). In large quarries N. E.....	..	X	..	..	..	..	X	X	..	..	..	..	..	..	..	X	..	..	X
Bennett, (20). Below town.............	X	X	..	..	..	..	..	..	X	..	..	X	..	..	..	..	..	..	X
Tecumseh, (21). Two miles below town....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tablerock, (22). In clay pits	..	X	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Between Tablerock and Humboldt, (23).....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dawson, (24). West of station; in R. R. cuts	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X	..	..
Falls City, (25) Near mouth of Pony Creek	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	X
Falls City, (26). Lehmer quarries S.-W	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wymore, (27). South of......	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Blue Springs (28) Across the Blue River ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Fistulipora carbonaria Ulrich				X	X	X	X	X	X	X		X					X	X	X			X						
Fistulipora carbonaria-nebrascensis Condra						X																						
Fistulipora nodulifera Meek	X	?		X	X	X	X	X	X	X	X	X	X	X		X	X		X	X		X		X				
Meekopora prosseri Ulrich	X																			X		X		X				
Pinnatopora pyriformipora Rogers	X											X																
Pinnatopora trilineata (Meek)	X										X	X		X														
Pinnatopora youngi Ulrich												X																
Polypora bassleri Condra		?	?	?	X	X	X	X			X						X	X	X									
Polypora cestriensis Ulrich																						X						
Polypora crassa Ulrich		X			X	X						X					X		X			X			X			
Polypora elliptica Rogers	X	X	X	X	X	X	X	X		X	X		X				X	X	X		X	X						X
Polypora remota Condra						X		X		X																		
Polypora reversipora Condra																						X						
Polypora spinulifera Ulrich					X	X	?				X								X			X		X				
Polypora stragula White														X					?									
Polypora submarginata Meek	X	X		X	X	X		X		X	X		X	X	X				X	X		X	X	X	X			
Polypora ulrichi Condra																				X		X	X		X			
Polypora whitei Ulrich						X	X																					
Rhombopora lepidodendroides Meek	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Septopora biserialis (Swallow)	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X			
Septopora biserialis-nervata Ulrich	X				X	X					X	X								X		X						
Septopora cestriensis Prout					X							X																
Septopora decipiens Ulrich		X										X																
Septopora multipora Rogers	X	?			X	X																						
Septopora pinnata Ulrich	X				X	X									X					X								
Septopora robusta Ulrich						X		X			X									X		X		X				
Stenopora carbonaria (Worthen)					X	X																						
Stenopora carbonaria-conferta Ulrich					X																							
Stenopora distans Condra					X	X					X																	
Stenopora heteropora Condra					X																							
Stenopora (?) polyspinosa (Prov). Condra					X						X									X		X						
Stenopora spinulosa Rogers					X	X					X																	
Stenopora tuberculata (Prout)					X																							
Streblotrypa prisca (Gabb and Horn)	X		X				X					X								X						X		
Thamniscus palmatus (Prov). Condra	X																											
Thamniscus pinnatus Condra	X				X															X				X	X			
Thamniscus sevillensis Ulrich	X																							?				

FORMER REPORTS ON BRYOZOA OF NEBRASKA

Only four authors have treated the subject. The first was Professor Geinitz who, in 1866, published under the title "Carboniferous und Dyas in Nebraska." He examined an incomplete set of fossils collected by Marcou from exposures along the Missouri River. The specimens included five species, four of which at that time were new. Geinitz referred them to described forms as indicated by the following outline:

GEINITZ'S IDENTIFICATION	PRESENT NAME
1. Stenopora columnaris (Schlotheim).	1. Fistulipora nodulifera Meek, 1872. According to Meek, the specimens observed by Geinitz may have been R. lepidodendroides Meek incrusted by F. nodulifera Meek. If this is true, then two new species were identified as Stenopora columnaris.
2. Polypora biarmica Keyserling.	2. Polypora stragula White, 1874.
3. Polypora marginata McCoy.	3. Polypora submarginata Meek, 1872.
4. Fenestella plebeja McCoy.	4. It is not known what species was observed by Geinitz. It may have been F. conradi Ulrich, 1890.
5. Synocladia virgulacea Phillips.	5. Septopora biserialis (Swallow), 1858.

Further argument is unnecessary to show that Geinitz, though an eminent authority, has given us little of value concerning the bryozoa of Nebraska.

The second contribution bearing on the bryozoa of the state was made by F. B. Meek in his "Report on the Paleontology of Eastern Nebraska," and published in "The Final Report of the United States Geological Survey of Nebraska and Portions of the Adjacent Territories," 1872, by F. V. Hayden, U. S. Geologist. During this survey, which began in a preliminary way in the fifties, but more definitely in 1867, Meek visited and collected from exposures along the Missouri River, and throughout the southeastern part of the state; he also secured

specimens from a number of shafts or borings in the same region. Seven species were found, four of which he described as new, while a fifth (F. perelegans) was given as provisionally new. Later research has proved him correct in his conclusions, and to-day five species of the state's bryozoa are ascribed to Meek. The following species were collected and described:

1. Fistulipora nodulifera Meek, 1872.
2. Rhombopora lepidodendroides Meek, 1872.
3. Polypora submarginata Meek, 1872.
4. Fenestella shumardi Prout, 1858. (F. perelegans [Meek] 1872). Meek observed that the specimens collected were not identical with Prout's species and gave the provisional name F. perelegans.
5. Fenestella, Undet. Sp. (Geinitz's plebeja, not McCoy).
6. Septopora (Synocladia) biserialis (Swallow), 1858.
7. Pinnatopora (Glauconome) trilineata (Meek), 1872.

This carefully prepared report has been of much service to students of paleontology.

The third report was made by the writer under the title, "New Bryozoa from the Coal Measures of Nebraska," and published in the December number of the American Geologist, 1902. The following species and varieties were then described as new:

Fistulipora carbonaria-nebrascensis
Cyclotrypa (?) barberi Ulrich
Meekopora prosseri Ulrich
Batostomella leia
Stenopora heteropora
Stenopora distans
Stenopora (?) polyspinosa (Provisional)
Fenestella cyclofenestrata
Fenestella spinulosa
Fenestella parvipora
Fenestella gracilis
Fenestella polyporoides
Fenestella conradi-compactilis
Fenestella subrudis

Fenestella binodata
Polypora bassleri
Polypora ulrichi
Polypora remota
Thamniscus pinnatus
Thamniscus palmatus (Provisional)
Cystodictya anisopora
Cystodictya lophodes

E. O. Ulrich furnished the descriptions and drawings for Cyclotrypa (?) barberi, and Meekopora prosseri.

In a later number (January 1903) of the American Geologist the different forms and conditions of growth of Rhombopora-lepidodendroides Meek were described by the writer.

The fourth and last report was given by Professor Erwin H. Barbour in Vol. I of the Nebraska Geological Survey, 1903. In that volume the species described in this paper were listed.

DESCRIPTIONS

SUBORDER CYCLOSTOMATA *Busk*

"Zoecia simple, tubular; walls thin, minutely porous; apertures plain, inoperculate, commonly raised; interspaces with or without strengthening tissue; marsupia and appendicular organs wanting; ooecium a large modified cell or an inflation of the zoarial surface." Represented in the state by a single family, Fistuliporidae Ulrich.

Fistuliporidae *Ulrich*

"Zoarium massive, lamellate or ramose, showing on the surface at irregular intervals maculae or monticules composed of clusters of vesicles and of zooecia slightly larger than the average; lunarium generally well developed, sometimes wanting; zooecial tubes cylindrical or somewhat compressed, thin-walled, with diaphragms; walls minutely porous; apertures usually direct, closed at times by perforated covers; vesicular tissue occupies the interzooecial space."

The family is quite well represented in Nebraska by three genera: Fistulipora McCoy, Cyclotrypa Ulrich, and Meekopora Ulrich.

Fistulipora *McCoy*

1850. Fistulipora McCoy, Ann. Mag. Nat. Hist., Ser. 2, III, p. 131.

For a complete bibliography, see Nickles and Bassler, Bull. 173, U. S. G. S., p. 266, 1900.

"Zoarium massive, lamellate, ramose, parasitic or free; under surface with a wrinkled epitheca; zooecia cylindrical or somewhat compressed, direct or almost so, thin-walled until near the surface, and provided usually with a few diaphragms, and

encircled by one or more series of vesicles; apertures subradially arranged about the maculae, ovoid, subtriangular or pyriform, the lunarium more or less strongly developed; surface between apertures smooth or granular." Two species and one variety have been found in the state, viz., F. nodulifera Meek, F. carbonaria Ulrich, and F. carbonaria-nebrascensis Condra. No other species have thus far been reported from the Coal Measures of America.

Genotype: Fistulipora minor McCoy=Calamopora incrustans Phillips. Range, Silurian-Coal Measures.

Fistulipora nodulifera *Meek*

PL. I, FIGS. 1-5.

1872. Fistulipora nodulifera Meek, Pal. Eastern Nebr., p. 143, pl. V, 5a-d.
1894. Fistulipora nodulifera, Keyes, Missouri Geol. Surv., V, pl. XXXIV, fig. 3.
1896. Fistulipora nodulifera, Smith, Proc. Amer. Phil. Soc., XXXV, p. 235.
1900. Fistulipora nodulifera Meek, Nickles and Bassler, Bull. 173, U. S. G. S., p. 272.
1901. Fistulipora nodulifera, Rogers, Kans. Uni. Quar., IX, No. 4, pp. 236, 238, etc.
1903. Fistulipora nodulifera Meek, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium usually found incrusting pieces of limestone, crinoid stems (Pl. I, Fig. 1), and other fossils often assuming false forms; by incrusting R. lepidodendroides Meek (Pl. I, Fig. 2.) it appears ramose. The incrusted specimen may be entirely concealed; in such cases, sections reveal the condition. The zoarium varies from a few millimeters to several centimeters in width; the thickness depends on the number of superimposed layers of zooecia. Surface with nodes or smooth, without true spines; nodes usually present and irregularly disposed. Zooecial apertures subcircular, 0.25 to 0.3 mm. in diameter, (much smaller in specimens at Tablerock and referred to the species) average about their own diameter apart, closer or farther apart

depending on the number of interstitial cells, larger on the nodes, directed obliquely away from axis of a node. Peristome in unworn specimens lifted into a prominent lip which usually extends about one-half way around the aperture. In some specimens the lip or lunarium is pointed and spine-like. Zooecia (autocells) short, prostrate at their inception, ascend with a slight obliquity to the surface; walls often incomplete, being formed on one side by interstitial cells; zooecial tubes circular in section, increase gradually in size at first, then continue with about the same diameter to the apertures. Diaphragms generally wanting. Vesicular tissue composed of many small vesicles slightly wider than deep; vesicles thin-walled, irregularly arranged about the zooecia, in one to three or more series between the latter.

This species may be confused with F. carbonaria Ulrich, and F. carbonaria-nebrascensis Condra, but is quite readily distinguished from each by the usual absence of tabulae and the presence of smaller and more numerous interstitial vesicles. The following from Meek, the author of the species, shows that Professor Geinitz may have confused the species with Stenopora columnaris (Schlotheim). "I can scarcely doubt that this is one of the specimens referred to Stenopora columnaris by Professor Geinitz, as it is common in the same localities from which he cites that species, some of the forms of which it nearly resembles in general appearance as well as in mode of growth." Meek regarded F. nodulifera as a member of the polypi.

Oocurrence—"Various localities in the Coal Measures of Nebraska, Iowa, Illinois, and other western states." Common at Southbend, Cedarcreek, Louisville, Dawson, Tablerock, Bennett, Roca, Weeping Water, Nehawka, Richfield, La Platte, Rockbluff, and Plattsmouth, Nebraska, being one of the well represented and widely distributed fossils of the state.

Fistulipora carbonaria *Ulrich*

PL. I, FIGS. 6-10.

1884. Fistulipora carbonaria Ulrich, Jour. Cincinnati Soc. Nat. Hist., VII, p. 45, pl. III, 1, 1a.
1894. Fistulipora carbonaria, Keyes, Missouri Geol. Surv., V, p. 16.
1900. Fistulipora carbonaria Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 267.
1901. Fistulipora, Sardeson, Jour. Geol., IX, No. 1, p. 14.
1903. Fistulipora carbonaria Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium laminar, discoid or massive, varying in thickness from a few millimeters to several centimeters; some nodular forms collected at Nehawka, and Louisville are two to eight cm. in diameter. Professor Erwin H. Barbour secured a specimen at Southbend, 1896, that is over an inch in diameter, subcircular in section, slightly compressed, and extends in a serpentine manner for about six inches. The nodular forms usually constrict from the base and again expand. Surface with low maculae, smooth; apertures subcircular to elliptical, about 0.35 mm. in diameter, less than their own diameter apart; peristome thin, sometimes elevated for about half the distance around the aperture. In sections, zooecia appear subovate, thin-walled, often contiguous at limited points, about equal in diameter throughout; anterior wall less regular than the posterior. Tabulae thin, pass directly or indirectly across the tube, about a tube's diameter apart. Interstitial vesicles irregular in form, vary in size, diameter one-fourth to three-fourths that of the zooecia (autocells); except in the maculae, they occur in single series between the zooecia. In some specimens the vesicles have quite a regular arrangement, forming series parallel with the zooecia.

The species is quite readily distinguished from F. nodulifera Meek by the larger apertures, fewer and larger vesicles, and the presence of diaphragms (tabulae). It is yet more closely related to F. minor McCoy, but differs in having one instead of two series of vesicles surrounding each zooecium; the latter

species does not have maculae and has not been reported from the Coal Measures.

Well preserved specimens show very little infiltrated matter in the vesicles and are easily sectioned. Specimens of this species present the external appearance of some corals.

Occurrence—Coal Measures: Kansas City, Missouri; Manhattan, Kansas; Nehawka, between Weeping Water and Nehawka, Weeping Water, Louisville, Cedarcreek, Southbend, Richfield, Tablerock, and Plattsmouth, Nebraska. It is one of the most common fossils in the quarry northeast of Nehawka, where many specimens were collected.

Fistulipora carbonaria-nebrascensis *Condra*

PL. II, FIGS. 1, 2.

1902. Fistulipora carbonaria-nebrascensis Condra, Amer. Geol., XXX, No. 6, pp. 337, 338,pl. XVIII, 1, 2.

1903. Fistulipora carbonaria-nebrascensis Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium large, massive; form irregular. A specimen collected at Louisville is 15 by 11 by 4.5 cm. in size, being the largest specimen of the genus yet found in the state. The surface is rendered irregular by large mastoid-like projections and by elevated maculae which are not very different from monticules. Maculae 5 mm. apart, with fair elevation, surrounded by apertures slightly larger than the average. Zooecia average 0.28 mm. in diameter, being smaller than in typical specimens of the species. The lunarium is more prominent. The tabulae are farther apart, while the interstitial vesicles vary more in size. This well marked variety can be distinguished by the clearly defined lunaria and relatively small zooecia. By some authors it would be classed as a coral. Type specimen No. 5-11-10-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Louisville, Nebraska.

Cyclotrypa *Ulrich*

1890. Nov. Gen. (?), Ulrich, Geol. Surv. Ill., VIII, p. 382.
1896. Cyclotrypa Ulrich, Zittel's Text-book Paleontology (Eng. Ed.), p. 269.
1900. Cyclotrypa Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 25.

The genus closely resembles Fistulipora, but the lunarium is obsolete and the zooecial tubes are circular in section. Genotype: Fistulipora communis Ulrich. Range, Devonian—Coal Measures (?). Represented in Nebraska by a single species, Cyclotrypa (?) barberi Ulrich, which may prove to be a member of the genus Fistulipora. This is the only species of the genus known by the writer to occur in the Coal Measures, and it should not be overlooked that its generic position is held in doubt. According to Nickles and Bassler, species now referred elsewhere may, in time, be placed here.

Cyclotrypa (?) barberi *Ulrich*

PL. II, FIGS. 3-9.

1902. Cyclotrypa(?) barberi Ulrich, Condra, Amer. Geol., XXX., No. 6, pp. 338, 339, pl. XVII, 3-8.
1903. Cyclotrypa (?) barberi Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

The following description, published in the American Geologist, Dec., 1902, was furnished the writer by E. O. Ulrich, the author of the species.

"Zoarium ramose dividing at rather long intervals; branches subcylindrical, commonly from seven to twelve mm. in diameter, but reaching 20 mm. in Texas specimens referred to the species. Maculae rather small, five or six mm. apart; zo :ecial apertures subcircular, nearly direct, separated by interspaces averaging a little less in width than their diameters, arranged in moderately regular rows, nine or ten in 5 mm.; peristomes ring-like carrying, on the side opposite the lunarium, which is distinguished only by its slightly greater elevation and comparative smoothness, seven to ten small perforated pustules. Similar pustules

are scattered among the much smaller granules covering the depressed interspaces. Here and there, especially in the maculae, a small pore of uncertain functions may be observed. Internal structure as shown in the accompanying illustrations. Named in honor of Manly D. Barber, of DeKalb, Illinois, from whom the first specimens seen of this well marked and widely distributed species were received.

The generic position of C. (?) barberi is uncertain, and we may add, so is that of a large proportion of the Fistuliporidae. The family requires thorough revision, and until that is attempted it would be, to say the least, unwise to create generic groups."

Type specimens in the collection of E. O. Ulrich (who not only gave the name, but has placed specimens in the National Museum under the above name), and No. 5-18-7-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska. The species is associated with Fistuliporae but is usually distinguished by the ramose growth.

Occurrence—Coal Measures: De Kalb, Illinois; Bartlesville, Indian Territory; Kansas City, Missouri; Pomeroy, Kansas; Texas; Louisville, Weeping Water, Nehawka, Cedarcreek, Southbend, LaPlatte, Tablerock, Roca, Bennett, and Plattsmouth, Nebraska. It is plentifully represented in the exposures across the Platte River from Louisville.

Meekopora *Ulrich*

1889. Meekopora Ulrich, Miller, N. Amer. Geol. Pal., p. 312.
1890. Meekopora Ulrich. Geol. Surv. Ill., VIII, pp. 383, 482, 483.
1896. Meekopora Ulrich, Zittel's Text-book Paleontology (Eng. Ed.), p. 270.
1897. Meekopora, Simpson, 14th Ann. Rep., St. Geol., New York, for the year 1894, p. 538.
1900. Meekopora, Nickles and Bassler, Bull. 173, U. S. G. S., pp. 26, 311.

"Zoarium bifoliate, sometimes branching; the mesotheca thin and flexuous; zooecia tubular, proceeding in a gentle curve from

the mesotheca, and opening somewhat obliquely upon the surface, and provided with numerous, often recurved, diaphragms; apertures oblique, all pointing distally; lunarium, when present, not very prominent; rather large ovicells developed, showing at the surface as a convex space with a small apical opening."

Genotype: Meekopora eximia Ulrich. Range, Silurian-Coal Measures. Represented in the state by a large number of specimens, all of which have been referred to M. prosseri Ulrich, the only species of the genus yet reported from the Coal Measures of America.

Meekopora prosseri *Ulrich*

PL. III, FIGS. 1-7.

1902. Meekopora prosseri Ulrich, Condra, Amer. Geol., XXX, No. 6, p. 339, pl. XVIII, 9, pl. XIX, 1-6.

1903. Meekopora prosseri Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

"Zoarium bifoliate, forming palmate fronds or frequently dividing branches eight to forty mm. wide, one to two mm. thick; edges of branches nonporiferous, subacute; zooecia opening on both faces of fronds, comparatively small, ovate, very slightly oblique, directed distally, separated by interspaces as wide or wider than their longer diameter, arranged in rather regular intersecting series, about eleven in five mm.; peristome thick, highest on the lower or lunarial side; interspaces, like the maculae, which are rather large and occur at intervals of four or five mm., concave and covered by minute granules.

This fine species is related to M. clausa Ulrich, a characteristic fossil of the Chester group, but is readily distinguished by its wider fronds, smaller zooecial apertures, and thicker interspaces.

The types of the species were collected some years ago by Professor Charles S. Prosser (Ohio State University) and submitted to the author for determination and description."

The above description was written by E. O. Ulrich, the author of the species, and published by the writer in the Ameri-

can Geologist, Vol. XXX, No. 6, p. 339, 1902. The following notes were then added to the description.

"Zoaria usually fragmentary, rarely over ten cm. high, generally four or five cm., one to three mm. thick, apertures 0.16 by 0.2 mm. across, eleven to thirteen in five mm. Diaphragms few, wanting in some tubes; vesicles numerous, arranged more or less in series, not very different in size in different parts of the zoarium, sometimes quite filled by a deposit near the surface. There are two forms of growth, one with narrow, and the other with wide branches." A thin form has less wide interspaces.

Occurrence—"Coal Measures: near Grenola, Elk county, Kansas" (Ulrich); Dawson, Tablerock, Bennett, and Roca, Nebraska. Quite plentifully represented at these places, especially at Dawson in the railroad cuts about one-half mile west of the B. & M. station. Professor Erwin H. Barbour secured the first specimens collected in the state at Roca, in 1896. Type specimens in the collection of E. O. Ulrich, and Nos. 18-10-00 and 15-12-7-01 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

SUBORDER TREPOSTOMATA *Ulrich*

"Zooecia prismatic or cylindrical, coherent tubes clearly separable into two regions, an axial or immature in which the diaphragms are remote and the walls thin and prismatic, and the thickened peripheral or mature, in which the walls are thickened and otherwise changed, diaphragms are more abundant, and accessory features, such as mesopores and acanthopores, are often developed; zooecial covers, with a small central orifice, present at times, though probably not developed in all the families; monticules or maculae a characteristic feature of the surface."

Represented in Nebraska by one family, Batostomellidae Ulrich.

Batostomellidae *Ulrich*

"Zoarium usually ramose; zooecia with thick walls in the mature region, appearing here to be fused; diaphragms in the peripheral region often centrally perforated; acanthopores and mesopores usually present, the latter small and sometimes moniliform in shape."

Represented in Nebraska by two genera: Batostomella Ulrich, and Stenopora Lonsdale.

Batostomella *Ulrich*

1882. Batostomella (in part) Ulrich, Jour. Cin. Soc. Nat. Hist., V, pp. 141, 154.
1886. Geinitzella, Waagen and Wentzel, Pal. Indica, Ser. XIII, pp. 875, 880.
1889. Batostomella, Miller, N. Amer. Geol. Pal., p. 294.
1890. Batostomella (in part) Ulrich, Geol. Survey, Ill., VIII, pp. 375, 432.
1895. Batostomella, Whidborne, Devon. Fauna England (Pal. Soc. Publ.), II, pt. 4, p. 187.
1896. Batostomella Ulrich, Zittel's Text-book Pal. (Eng. Ed.), p. 105.
1896. Geinitzella Ulrich, Zittel's Text-book Pal. (Eng. Ed.), p. 105.
1900. Batostomella, Nickles and Bassler, Bull. 173, U. S. G. S., p. 32.

Zoarium ramose; branches slender; zooecia with few diaphragms; apertures small, circular to oval; interspaces rounded or canaliculate, spinulose; acanthopores small, usually numerous; mesopores small, with subcircular openings.

Genotype: Batostomella spinulosa Ulrich. Range, Silurian-Coal Measures. Represented in the state by a single species, Batostomella leia Condra, and probably by a few specimens with doubtful affinities, which may yet be referrrd to the genus. So far as the writer knows, this is the first reported occurrence of the genus above the Chester.

Batostomella leia *Condra*

PL. III, FIGS. 8-14; PL. IV, FIGS. 1, 2.

1902. Batostomella leia Condra, Amer. Geol., XXX, No. 6, pp. 339, 340, pl. XIX, 7-10.
1903. Batostomella leia Condra, Barbour, Nebr. Geol. Surv., I, p. 127, pl. II, 8.

Zoaria consist of slender irregularly branching stems, supported by basal expansions. Branches circular in section, 2 to 5 mm. in diameter; surface minutely papillose, smooth when worn. Cell apertures subcircular inform, small, quite the same in size, 0.14 to 0. 16 mm. across, twelve to fifteen in 5 mm., usually not arranged in regular series. Interspaces with minute spines or smooth, about as wide or wider than the zooecial apertures; less wide in young specimens; thickened interspaces or small areas about 2 mm. apart may occur on the surface of the zoarium.

Zooecia long, vertical in the primitive portion, bend slowly to the surface; walls thin, polygonal to subcircular in section in the axial region, thickened near the apertures. Tubes long and large in the immature regions, but somewhat contracted in the cortical portions; in some specimens they extend through the zoarian in a manner that suggests relations to the genus Rhabdomeson. (See pl. IV, fig 1.)

Acanthopores short, quite numerous, small and large; irregularly disposed in the zooecial walls; large acanthopores, occurring at some cell angles, few in number, 0.6 mm. in diameter; small acanthopores 0.02 to 0.04 mms. in diameter. Tabulae scarce, absent in most zooecia. Mesopores few, small, irregular in form.

On account of the even cylindrical surface, small apertures, wide interspaces, and thin mature regions, this species is quite readily distinguished from the associated species, R. lepidodendroides Meek, and S. polyspinosa (Prov.). The interspacial areas when present will also serve in its identification. It is clearly distinct from all described species of Batostomella, but, on account of the presence of a few large acanthopores, may

be confused with R. lepidodendroides Meek. Other characters enumerated will amply serve for distinction. The axial part of each branch weathers rapidly, giving a hollow appearance to the ends, thus imitating the central tube found in the genus Rhabdomeson Young and Young.

Few specimens have been collected. One was sent to E. O. Ulrich, who pronounced it new and a member of the genus Batostomella. The name is suggested by the even surface, which appears smooth in specimens slightly worn. Type specimens No. 15-18-3-99 in the Morrill collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence--Coal Measures: Southbend, and Bennett, Nebraska.

Stenopora *Lonsdale*

1844. Stenopora Lonsdale, Darwin's Volcanic Islands, Appendix p. 161.

For a complete bibliography, see Nickles and Bassler, Bull. 173, U. S. G. S., pp. 408, 409, 1900.

"Zoarium ramose, sublobate, massy, laminar or parasitic; surface smooth or with monticules; walls of zooecia thickened periodically in the mature region; diaphragms sometimes very few, but in most American species abundant in the mature regions and perforated centrally; mesopores never very numerous, irregularly distributed; large acanthopores at the junction angles."

Genotype: Stenopora tasmaniensis Lonsdale. Range: Mississippian—Coal Measures. Represented in the Coal Measures of America by nine species, one provisional form, and two varieties, of which the following have been found in Nebraska: S. spinulosa Rogers, S. tuberculata (Prout), S. heteropora Condra, S. distans Condra, S. carbonaria (Worthen), S. carbonaria-conferta Ulrich, and S. polyspinosa (Prov.) Condra. The distribution of the genus, both horizontal and vertical, is limited in extent.

Stenopora spinulosa *Rogers*

PL. IV, FIGS. 3-5.

1900. Stenopora spinulosa Rogers, Kans. Univ. Quar., IX., No. 1, pp. 1, 2. pl. IV, 5.

1903. Stenopora spinulosa Rogers, Barbour, Nebr. Geol. Surv., I, p. 128.

Zoarium thin, spreading over brachiopods, one to two cm. across, consisting of a single layer of zooecia, rarely superimposed; surface montiferous; monticules two and one-half mm. apart from apex to apex. Cylindrical stems two mm. in diameter and quite closely resembling Rhombopora lepidodendroides Meek, sometimes arise from the surface. Under surface of zoarium provided with an epitheca. Apertures subcircular to polygonal, not in definitely arranged lines, 0.2 to 0.25 mm. across, fifteen or sixteen in five mm., slightly larger on the monticules where they are 0.26 to 0.28 mm. in diameter. Interspaces average 0.07 mm. in width. Zooecia short, about one mm. long, expand rapidly from their inception, at first procumbent, and then with an abrupt bend, pass directly to the surface; walls about equal in thickness throughout their length, containing many small closely placed acanthopores; large acanthopores also fairly numerous, occurring at the so-called cell angles and irregularly placed along the walls between the angles; they may project from the surface of the zoarium as spines. Mesopores small, few in number, subcircular in section. Diaphragms usually absent.

Rogers did not study the internal characters of this species, yet his conclusions were correct, to be based, as they were, on the surface characters. "This species is very similar to S. ohioensis Foerste. The acanthopores are more numerous and there is a greater contrast between the large and small acanthopores. There are six instead of ten apertures in a space of two mm." The writer is of the opinion that the species named are quite dissimilar. In addition to the differences enumerated, it should be noted that the zooecial walls in this species are not moniliform, but are distinctly so in that species. Speci-

mens collected in this state and thought to be identical with typical specimens are not very distinct from the incrusting form and basal portions of Rhombopora lepidodendroides Meek identified by the writer. The main difference is found in the number and disposition of the large acanthopores.

Occurrence—Coal Measures: Malvern, Osage county, Kansas; Southbend, Louisville, and La Platte, Nebraska. Only a few specimens have been secured in this state.

Stenopora tuberculata (*Prout*)

PL. IV. FIG. 6.

1859. Flustra tuberculata Prout, Trans. St. Louis Acad. Sci., I, p. 447, pl. XVII, 3-3f.
1860. Cyclopora polymorpha Prout, Trans. St. Louis Acad. Sci., I, p. 578.
1866. Cyclopora polymorpha Prout, Geol. Surv. Ill., II, p. 421, pl. XXI, 5-5b.
1894. Stenopora tuberculata, Keyes, Missouri Geol. Surv., V, p. 15.
1900. Stenopora tuberculata (Prout), Nickles and Bassler, Bull. 173, U. S. G. S., p. 411.
1903. Stenopora tuberculata (Prout), Barbour, Nebr. Geol. Surv., I, p. 128.

Nebraska specimens represent a variety with the following characters: Cell apertures rhomboidal, rarely subcircular, arranged in quite definite series or lines, 0.21 to 0.25 mm. in diameter, fifteen occurring in five mm. Interspaces 0.05 to 0.07 mm. wide. Large acanthopores extend from the angles of the cells as prominent spines.

The apertures have a more linear arrangement; walls are thicker, and the acanthopores more prominent than in typical specimens of the species. This variety is quite closely related to S. cestriensis Ulrich.

Occurrence—Warsaw group: Bennett's station, Missouri (Prout). St. Louis group: Several localities. Chester group: Pope county (Prout) and Chester, Illinois; Grayson Springs

and Sloan's Valley, Kentucky. Coal Measures: Southbend, Nebraska, by a single well preserved specimen.

Stenopora heteropora *Condra*

PL. IV, FIGS. 7, 8.

1902. Stenopora heteropora Condra, Amer. Geol., XXX, No. 6, pp. 340, 341, pl. XX, 1, 2.
1903. Stenopora heteropora Condra, Barbour, Nebr. Geol. Surv., I, p. 128.

Zoarium massive or incrusting; surface with clusters of elevated apertures larger than the average; clusters 1.5 mm. across, four or five mm. apart. Apertures polygonal or rhomboidal, more or less in series about the clusters, 0.24 to 0.4 mm. across, average 0.26 to 0.3 mm., fourteen or fifteen in five mm. Interspaces thin, 0.05 to 0.06 mm. wide. Zooecia about three mm. long; at first horizontal, and then with a quick curve, they pass direct to the surface; tubes polygonal, average diameter 0.27 mm., walls thin, usually not more than 0.02 mm. thick; near the surface they increase in thickness equal to that of the interspaces. Diaphragms thin, five to eight in each tube, about 0.26 mm. apart in the straight portion of each tube. Acanthopores few, of medium size, located at the cell angles. The line of division between adjacent zooecia is quite plain. The writer knows of no species of the genus more closely related to the genus Anisotrypa.

The nearest related species is S. rudis Ulrich from which this differs mainly in zoarial form. The zoarium of that species consists of hollow, irregular branches, while this is incrusting or massive. The walls, in section, resemble those of S. cestriensis Ulrich, but show smaller acanthopores and plainer divisional lines between the adjacent zooecia. The main points of specific importance are to be found in the varying sizes of the zooecial apertures and in the form of the zoarium. Type specimen No. 21-3-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Southbend, Nebraska.

Stenopora distans *Condra*

PL. V, FIGS. 6-9.

1902. Stenopora distans Condra, Amer. Geol., XXX, No. 6, p. 341, pl. XX, 3-5.

1903. Stenopora distans Condra, Barbour. Nebr. Geol. Surv., I, p. 128.

Zoarium an expanded crust, consisting of a single layer of zooecia, supported by a wrinkled epitheca; thickness 2 to 3 mm.; width variable, average about 3 cm.; surface spinulose when not worn, with low monticules or smooth. Apertures subcircular, not in regular lines, unequal in size, averaging 0.25 mm. in diameter, fifteen or sixteen in 5 mm. Interspaces thick, with rounded surface, unequal in width, sometimes 0.15 mm. or more wide. Zooecia 2 to 3 mm. long, quite straight throughout the entire length; walls quite thick throughout the length of each tube, not plainly moniliform; zooecial tubes subcircular in section, of unequal diameters, varying from 0.16 to 0.28 mm. Large acanthopores occurring at some of the cell angles are 0.1 to 0.12 mm. in diameter, regular in form, circular in section, and slightly more than half as numerous as the zooecia; small and less regular acanthopores, 0.03 to 0.05 mm. in diameter, occur in the walls between the large acanthopores; the number varies from about 10 to 15 surrounding each zooecium. Diaphragms thin, three to seven in each tube, irregularly disposed. Mesopores small, irregular in section, one-third to one-half as numerous as the zooecia.

To a limited extent, this species resembles S. spinulosa Rogers, in having similar though larger and less numerous large acanthopores which are not disposed as they are in that species. Related to S. signata Ulrich, but differs mainly in form. The wide interspaces and the varying sizes of the zooecia serve as the main specific characters. The diaphragms are also of use in separating it from related species. Recently an irregular ramose form was found at Southbend. It is about the size of the old growth of R. lepidodendroides, but can be distinguished by the number of diaphragms and other characters observed in

the incrusting form. Type specimen No. 11-10-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Louisville, Southbend, and La Platte, Nebraska.

Stenopora carbonaria (*Worthen*)

PL. IV, FIGS. 9-13.

1875. Chaetetes (?) carbonaria Worthen, Geol. Surv. Ill., VI, p. 526, pl. XXXII, 5.
1887. Stenopora carbonaria, Foerste, Bull. Sci. Lab., Denison Univ., II, p. 85; ibid., III, 1888, pl. VIII, 13a-c.
1890. Stenopora carbonaria, Ulrich, Geol. Surv. Ill., VIII, p. 445, pl. LXXIII, 8, 8a.
1900. Stenopora carbonaria (Worthen), Nickles and Bassler, Bull. U. S. G. S., p. 409.
1901. Stenopora carbonaria, Rogers, Kans. Univ. Quar., IX, No. 4, pp. 239, 240, 245.
1903. Stenopora carbonaria (Worthen), Barbour, Nebr. Geol. Surv., I, p. 128.

Worthen was in doubt about the systematic position of this species, and placed it under the polypi; his description was meagre. Foerste added more definiteness to the description and placed the species with its proper genus. Later, E. O. Ulrich gave the following description: "Zoarium ramose, consisting of subcylindrical branches, varying in diameter from 10 to 15 mm. Surface smooth, not exhibiting groups of cells marked by differing from the average size. Zooecial apertures angular and subcircular, with either thick or thin interspaces, about ten or eleven in 3 mm. Walls of zooecial tubes moniliform in the cortical region, the swellings irregular, often merging into each other, at other times separated by a thin interval, twelve to fourteen in 2 mm. Thin, centrally perforated diaphragms developed in the mature zöoecia and about a tube's diameter apart; none were observed in the axial region. Mesopores almost wanting. Acanthopores large, fairly numerous. The divisional

lines between the thickened portion of the walls of the zooecia is marked by a series of minute dark spots." The above description covers typical forms of the species. Ulrich has also added two varieties.

Few specimens have been collected in Nebraska. Professor Erwin H. Barbour secured the first at Southbend, 1896. It is a cylindrical branch, 8 mm. in diameter, having subcircular apertures 0.25 mm. across, with seventeen occurring in 5 mm.

Occurrence—Coal Measures: Caseyville, and Peoria, Illinois; Licking county, Ohio; Lawrence, Kansas; Southbend, and Louisville, Nebraska.

Stenopora carbonaria-conferta *Ulrich*

PL. IV, FIGS. 14, 15.

1890. Stenopora carbonaria var. conferta Ulrich, Geol. Surv. Ill., VIII, p. 446, pl. LXXIII, 9, 9a.

1900. Stenopora carbonaria-conferta Ulrich, Nickles and Bassler, Bull. 173 U. S. G. S., p. 409.

1903. Stenopora carbonaria-conferta Ulrich, Barbour, Nebr. Geol. Surv., I, p. 128.

"This variety has the beads of the moniliform walls more closely set, there being in the peripheral region ten or eleven in 1 mm. The moniliform character of the walls is more pronounced in this variety than in any other form of the genus known to me, except S. ohioensis Foerste."

As yet, only one good specimen has been found in the state; it was secured at Southbend, by Professor Erwin H. Barbour, 1896.

Occurrence—Coal Measures: Caseyville, Illinois; Southbend, Nebraska.

Stenopora (?) polyspinosa (PROVISIONAL) *Condra*

PL. V, FIGS. 1-5; PL. VI, FIG. 1

1902. Stenopora *(?)* polyspinosa *(*Provisional*)* Condra, Amer. Geol., XXX, No. 6, pp. 340, 341, 342, pl. XX, 6-10.

1903. Stenopora (?) polyspinosa (Provisional) Condra, Barbour, Nebr. Geol. Surv., I, p. 128, pl. V, 7.

Zoarium recently found in the incrusting form (Pl. V, fig. 7), usually ramose, consisting of subcylindrical branches 4 or 5 mm. in diameter. Bifurcations far apart, with variable angles, usually small. Surface smooth except for numerous small and a few large acanthopores which project on the interspaces as low, blunt spines; the former give the surface a papillose appearance. Interspaces thin when perfectly preserved, thickened where worn, average width 0.07 or 0.08 mm. Zooecial apertures subcircular to polygonal, generally polygonal, not in regular series, 0.25 to 0.30 mm. in diameter, thirteen or fourteen in 5 mm. Zooecia quite long, vertical in the axial region, curving gradually to the cortical portion and then passing in nearly straight lines to the surface. Walls in the immature portion thin, polygonal, 0.02 mm. thick, thickened, finely laminated and not moniliform in the thin, cortical region. Small acanthopores 0.04 to 0.07 mm. in diameter, averaging larger and more numerous than in typical R. lepidodendroides Meek. A few large acanthopores occur at some cell angles. Zooecial cavities about equal in diameter throughout, slightly smaller in the cortical region. Diaphragms few in number, about one for each zooecium, usually placed at the inner border of the mature region of each tube. Mesopores small, irregular in form, about one-fourth as numerous as the zooecia.

The writer is in doubt about the systematic position of this provisional species. It may eventually be placed with either of the genera Rhombopora, Stenopora or Batostomella. When some one either combines or establishes the limits of these genera, which in some respects are not very dissimilar, it can be correctly placed if it proves a valid species. Several specimens were collected; they may be a species of Rhombopora related to R. crassa and R. lepidodendroides. Further, they may prove to be a peculiar form of an old growth of the latter. Rhombopora crassa Ulrich has a thicker cortical region, no large acanthopores and the zooecia are not as long and appear less vertical in the axial region. There are not

enough large acanthopores in the provisional form to place it with R. lepidodendroides Meek; also, other characters enumerated make them dissimilar. Stenopora spissa Rogers seems to closely resemble the species just named. The apertures are not like those of most species of Batostomella, but the walls, mesopores, and small acanthopores resemble to a degree the same in that genus. Distinguished from B. leia by the larger apertures of a different form, and by the somewhat thicker mature region. The specimens seem to fit better with Stenopora than with either of the other genera.

The incrusting form was found at Bennett, Nebraska. Type specimen No. 4-18-3-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Southbend, La Platte, Bennett, and Tablerock, Nebraska.

SUBORDER CRYPTOSTOMATA *Vine*

"Zooecia short, pyriform to oblong, quadrate or hexagonal, sometimes tubular; orifice anterior, usually circular; the upper or front side of the zooecium strengthened by a calcareous deposit, solid or vesicular in nature, which as it proceeds, leaves an opening above the orifice, thus producing a shaft or vestibule, which may be crossed by diaphragms or hemisepta." Represented in the Coal Measures of the state by four families: Fenestellidae King, Acanthocladiidae Zittel, Cystodictyonidae Ulrich, and Rhabdomesontidae Vine.

Fenestellidae *King*

"Zoarium a reticulated expansion, celluliferous on one side only, composed of rigid branches, united by regular non-poriferous bars (dissepiments), or branches may be sinuous and anastomose at regular intervals, or may remain free; zooecia oblong, quadrate, or hexagonal in outline, embedded in a calcareous crust which is minutely porous, especially on the non-celluliferous side; orifice anterior, semielliptical, truncated

behind; apertures rounded, with peristome and closed at times by a centrally perforated closure; a superior hemiseptum generally present, an inferior one less frequently." The family is well represented in the state by three genera: Fenestella Lonsdale, Polypora McCoy, and Thamniscus King.

Fenestella *Lonsdale*

1839. Fenestella Lonsdale, Murchison's Silurian System, p. 677.

For a long and complete bibliography, see Nickles and Bassler, Bull. 173, U. S. G. S., pp. 244, 245, 1900.

"Zoarium flabellate or funnel-shaped, celluliferous on the inner side; branches generally straight, sometimes flexuous, connected at regular intervals by dissepiments; apertures in two rows, separated by a plain or tuberculated median keel." This is the best represented genus found in the Coal Measures of America. Two species, F. cyclofenestrata and F. polyporoides, closely resemble the Polyporae in that three ranges of zooecia may occur on the branches below a bifurcation. However, the writer believes that such intermediate forms should not be placed under the genus Flabelliporina recently proposed by Simpson. Fenestella and Polypora are very closely related genera, and all of their species may yet be placed under the first name. The following Fenestellae occur in the state: F. mimica Ulrich, F. limbata Foerste, F. tenax Ulrich (?), F. cyclofenestrata Condra, F. spinulosa Condra, F. perelegans (Meek), F. conradi Ulrich, F. conradi-compactilis Condra, F. parvipora Condra, F. subrudis Condra, F. gracilis Condra, F. kansanensis Rogers, F. polyporoides Condra, and F. binodata Condra.

F. mimica and F. limbata, as found here, are very similar; they do not seem to represent distinct species. It does not seem best to give a new name to the Coal Measure representatives of these closely related species. Two specimens doubtfully referred to F. missouriensis Rogers were collected.

Accepted Genotype: F. plebeja McCoy. Range, Ordovician-Permian.

Fenestella mimica *Ulrich*

PL. VIII, FIG. 1.

1890. Fenestella mimica Ulrich, Geol. Surv. Ill., VIII, p. 552, pl. LII, 7, 7a.

1900. Fenestella mimica Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 255.

1903. Fenestella mimica Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium as shown by incomplete specimens found in Nebraska, a small foliar expansion.

Branches straight, with few bifurcations, small, varying from 0.19 to 0.25 mm. in width, with twelve to fourteen, usually twelve or thirteen, in 5 mm. "Carina, a very faint but little projecting line, bearing a row of small spines 0.12 mm. apart." Dissepiments one-third as wide as the branches, depressed on the obverse, expanded terminally, not much depressed on the reverse face. Fenestrules subquadrangular, strongly concave at the sides, 0.35 mm. long by 0.2 mm. wide, about twelve in 5 mm. Zooecia in two alternating ranges; the arrangement is such that one aperture occurs at the end of each dissepiment with another midway between or at the side of the fenestrule. Apertures rarely more than two to each fenestrule, infrequently three, about their own diameter apart, large, circular, with quite prominent peristomes, twenty-four to twenty-five in 5 mm.

This species is related to F. tenax Ulrich, but has larger apertures, and, in typical specimens, no keel. F. spinulosa Condra is coarser and has fewer zooecia. F. limbata Foerste, found in this state, is very closely related.

Occurrence—Coal Measures: Seville, Illinois; Louisville, Bennett, Plattsmouth, and Roca, Nebraska.

A few other specimens from Roca and Bennett are for the present placed here. They have slender branches, 0.21 mm. in diameter, with fifteen in 5 mm. The carina is thin, seemingly without spines. Dissepiments thin; fenestrules a little narrower than in typical specimens of the species. There are about twenty-eight zooecia in 5 mm., with two or three, in each series,

to the fenestrule. These specimens, it appears, should be classed here rather than with F. tenax Ulrich, yet they represent some of the characters of each species. The apertures resemble the same of F. mimica rather than F. tenax.

Fenestella limbata *Foerste*

PL. VIII, FIGS. 2, 3.

1887. Fenestella limbatus Foerste, Bull. Sci. Lab. Denison Univ., II, p. 83, pl. VII, 10a-d.
1900. Fenestella limbata (Foerste), Nickles and Bassler, Bull. 173, U. S. G. S., p. 254.
1901. Fenestella limbata, Rogers, Kans. Univ. Quar., IX, No. 4, pp. 240, 245.
1903. Fenestella limbata Foerste, Barbour, Nebr. Geol. Surv., I, p. 127.

Nebraska specimens referred to this species, are little more than a variety of F. mimica. They do not typically represent the species, and may be described as follows: Zoarium, a reticulate expansion of medium size. Branches rigid, cylindrical, 0.23 to 0.25 mm. wide, twelve to fourteen in 5 mm.; bifurcations 0.5 to 1 cm. apart, with acute angles; reverse face prominently striated, striae more parallel than with F. elevatipora Ulrich. The obverse face has a straight and definite carina, not much elevated, 0.4 to 0.6 mm. across, with a row of small subconical spines placed about 0.21 mm. apart; nodes as wide as the keel.

Dissepiments, on the reverse, straight, cylindrical, and only faintly expanded terminally, not quite on a level with and one-third to one-half as wide as the branches; on the opposite face, depressed, about equal in size, and, at times, striated. Fenestrules rectangular on the reverse, 0.3 to 0.34 mm. long by 0.15 to 0.18 mm. wide; the form, in Nebraska specimens, is more nearly a rectangle than with either F. tenax or F. mimica; on the obverse face they are about twice as long as wide, modified by the slightly expanded dissepiments and zooecial apertures, 0.28 to 0.33 mm. long, and 0.14 to 0.18 mm. wide.

Zooecia in two regularly alternating ranges, with two and sometimes three in each row to the fenestrule. Apertures large, about their own diameter apart including the peristome, subcircular or pyriform, with well-defined and elevated complete or incomplete peristome which may not completely encircle the aperture below, project into the fenestrule, 0.07 by 0.09 mm. across, 0.11 by 0.14 mm. across with the peristome, twenty-three to twenty-five in 5 mm. Nebraska specimens seem to be more delicate than were those described by Foerste.

Specimens found in Nebraska closely resemble F. tenax Ulrich, and F. mimica Ulrich. The reverse face is most like F. tenax, but can be distinguished by the less elliptical fenestrules. On the obverse face, the apertures are larger and of a different character; the carina is not so wide. The carina, slightly encroaching apertures, and prominent striae, serve to separate the species from typical F. mimica Ulrich. F. cyclofenestrata Condra is quite distinct.

Occurrence—Coal Measures: Flint Ridge, Ohio; Bennett, Nebraska.

Fenestella tenax *Ulrich* (?)

PL. VIII, FIG. 4.

1888. Fenestella tenax Ulrich, Bull. Denison Univ., IV, p. 71.
1890. Fenestella tenax Ulrich, Geol. Surv. Ill., VIII, p. 546, pl. LI, 2-2e.
1894. Fenestella tenax, Keyes, Missouri Geol. Surv., V, p. 24.
1900. Fenestella tenax Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 263.
1903. Fenestella tenax Ulrich (?), Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a delicate foliar expansion. "Branches slender, bifurcating at distant intervals, from 0.2 to 0.3 mm. (the latter just before bifurcating) wide. Dissepiments thin, rounded, one-fourth to one-third as large as the branches. Fenestrules long, oval, 0.3 long and 0.12 wide, indented once on each side when perfect. Carina strong, elevated with declining sides, bearing

traces of numerous small spines. Zooecia in two ranges, with pustulose mouths. Apertures circular, small, more than their own diameter apart, usually situated, one opposite the end of each dissepiment and one opposite the middle of each fenestrule. On the reverse, the branches show obscure striation and granulation, the dissepiments are thin, on a plane with the branches or a little depressed below them, wider and more rectangular than on the obverse."

Specimens from the Warsaw beds have fourteen or fifteen branches, fourteen and one-half or fifteen fenestrules, and twenty-nine or thirty zooecia in 5 mm. Chester group forms have about as many bránches and fenestrules and twenty-seven or twenty-eight zooecia in 5 mm; also another variety has about twelve fenestrules and twenty-four or twenty-five zooecia in 5 mm. Perhaps no specimen collected in this state is typical. These specimens represent a coarse variety with the following description and might be classed as a variety of F. cyclofenestrata.

Branches straight or irregular in extent, quite plainly striated on the reverse, with twelve or thirteen in 5 mm.; dissepiments strong. Carina stonger than in typical specimens, bearing few spines. Fenestrules elliptical on the reverse. Zooecia not regularly placed at the ends of dissepiments, with about twenty-three or twenty-four in 5 mm. Apertures of medium size; peristome sometimes fairly well developed.

Occurrence—Undisputed specimens occur—"Warsaw: Warsaw and Monroe county, Illinois; Chester: Chester and Kaskaskia, Illinois; Sloan's Valley, Kentucky. Waverly: Cuyahoga county, Ohio."

Nebraska specimens—Coal Measures: Ashland, Southbend, Falls City, Bennett, and Nehawka, Nebraska.

Fenestella cyclofenestrata *Condra*

PL. IX, FIGS 1-5.

1902. Fenestella cyclofenestrata Condra, Amer. Geol., XXX, No. 6, pp. 342, 343, pl. XXI, 1-3.

1903. Fenestella cyclofenestrata Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a reticulate expansion apparently of large size; of a number of incomplete zoaria collected, each is over 4 cm. across. Branches straight or slightly flexuous, average width 0.25 mm., twelve to fourteén in 5 mm., 0.35 mm. wide immediately below bifurcations, which are far apart and with very acute angles; reverse face evenly and slowly rounded, smooth or faintly striated; the obverse shows a broad, evenly elevated area 0.07 to 0.1 mm. across; spines not observed to be present. Frequently the area is more elevated and appears as a broad carina. Dissepiments on the reverse face, as wide as long, over one-half as wide as the branches, on a level with the latter, much expanded terminally; dissepiments not much depressed and strong on the obverse; they and the branches slope evenly to the fenestrules. Fenestrules on the reverse, circular or subcircular, modified by the terminally expanded dissepiments, average 0.2 mm. long, a little longer and less wide on the opposite face, with about twelve in 5 mm.

Zooecia in two regularly alternating ranges (at times three for a short distance below a bifurcation). The two ranges are widely separated by the broad area. Apertures, circular or subcircular, usually two, rarely three in each row to the fenestrule, 0.08 mm. across, 0.12 mm. across including the peristome, with the peristome slightly less than their own diameter apart, twenty-four in 5 mm.

These specimens are not apt to be confused with any of the described species. The reverse face resembles, to a degree, that of F. conradi Ulrich, but has smaller proportions and no perforated nodes. The circular to subcircular fenestrules, wide area or carina, and rather robust appearance serve to distinguish the specimens from related species; some authors would classify them with the genus Polypora. The name is suggested by the circular fenestrules of the reverse face. Type specimens No. 12-7-01 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Bennett, Nebraska. Quite

plentifully represented at that locality, being found in a thin layer of impure limestone, in the creek bed, about two miles below town.

Fenestella spinulosa *Condra*

PL. X, FIGS. 1-5.

1902. Fenestella spinulosa Condra, Amer. Geol., XXX, No. 6, pp. 343, 344, pl. XXI, 4-6.

1903. Fenestella spinulosa Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a large fan-shaped expansion, commonly found imperfect, but well preserved. One complete abnormal zoarium, resembling Ptilopora in mode of growth, is 4 cm. high by 3 cm. wide. The main branches, 0.28 to 0.3 mm. in width, give rise, from their sides at very acute angles, to smaller branches 0.2 to 0.25 mm. wide. Branches of normal zoaria, on the reverse, straight, cylindrical, faintly striated or granulose, 0.2 to .28 mm. wide, varying with condition of growth and place in zoarium, usually more than their own diameter apart, farthest apart in the periphery, from eight to ten in 5 mm. Carina quite well elevated, bearing a row of prominent conical spines. Spines disposed so that one occurs near the end of each dissepiment with another between, average 0.25 mm. apart from apex to apex, 0.07 to 0.1 mm. in diameter at their bases, much larger and obscure the apertures in old growth.

Dissepiments on the reverse straight, cylindrical, expanded very little terminally, not much depressed, average width one-third that of the branches; depressed on the obverse face. Fenestrules short-rectangular to rectangular, vary in size, 0.35 to 0.45 mm. long, 0.25 to 0.35 mm. wide, nine or ten in 5 mm.; less regular in form on the obverse and only slightly modified by zooecial apertures.

Zooecia small, in two alternating ranges. Apertures subcircular in form, nearly two diameters apart, two in each range to the fenestrule, nineteen or twenty in 5 mm.; peristomes faint, in some specimens pustuliform, project little into the fenestrule.

There are two forms of growth. One of which has strong branches (about their own diameter apart), stout dissepiments, and rectangular fenestrules; the other form is more lax in growth, having wider fenestrules, as well as thinner branches and dissepiments. Specimens belonging to the last named form were at first classified as F. sevillensis Ulrich on account of characters of the reverse face. As soon as the obverse was seen, they were correctly placed. F. perelegans (Meek), an associated species, resembles F. spinulosa in general measurements, but has very thin, depressed dissepiments on the reverse; the obverse faces are quite dissimilar.

The distinguishing characters are the large spines on a definite carina, and the small zooecia. Type specimens, No. 10-8-7-00 and 4-7-4-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Roca, and Dawson, Nebraska. This is a common fossil in the Warner quarry one mile north of Roca, where it is found in impure limestone.

Fenestella perelegans (*Meek*)

PL. VIII, FIGS. 5, 6.

1872. Fenestella perelegans Meek, Pal. Eastern Nebraska, p. 153, pl. VII, 3, 3d, (proposed under F. Shumardi Prout.)

1885. Fenestella perelegans, Waagen and Piehl, Pal. Indica, Ser. XIII, p. 777, pl. LXXXVII, 1-3.

1894. Fenestella shumardi (not of Prout), Keyes, Missouri Geol. Surv., V, p. 24, pl. XXXIV, 2a-b.

1896. Fenestella shumardi (not of Prout), Smith, Proc. Amer. Phil. Soc., XXXV, p. 237.

1900. Fenestella perelegans (Meek), Nickles and Bassler, Bull. 173, U. S. G. S., p. 258.

1901. Fenestella perelegans, Rogers, Kans. Univ. Quar., IX, No. 4, pp. 238, 243, 245.

1903. Fenestella perelegans (Meek), Barbour, Nebr. Geol. Surv., I, p. 127.

This species was reported by Meek, 1872, under the name of

F. shumardi Prout, but as provisionally new for which the name F. perelegans was proposed in the event the specimens proved not identical with Prout's species. Since the time of Prout and Meek, the careful studies of Ulrich, Hall, Foerste, and others, have made it possible to give more accurate specific determinations of the fenestelloids than was possible for those earlier and careful workers. However, this is not a strong species.

As yet only a few good specimens have been collected by me in the state. They show the reverse face and are the basis for a part of the following description: Zoarium a regular foliar expansion of large size, subcircular in form. Branches straight, about equal in size, cylindrical, with longitudinal striae, about their own diameter apart, spreading very little at bifurcations, 0.25 mm. wide, with nine or ten in 5 mm. Dissepiments thin, 0.07 mm. wide, straight, with very little terminal expansion, much depressed. Fenestrules oblong averaging 0.38 to 0.4 mm. long and 0.25 mm. wide, nine or ten in 5 mm.

"Poriferous side with mesial carina, apparently sometimes bearing minute projecting points, and on each side of the angle, about two and sometimes three comparatively large pores, generally arranged so there is one at each end of each dissepiment, and another between these, opposite each side of each fenestrule." Worn portions of the zoarium show nineteen large zooecia in 5 mm.

Occurrence—Coal Measures: Nebraska City, and Roca, Nebraska; "Poteau Mountain, Indian Territory." (Smith.)

Fenestella conradi *Ulrich*

PL. VIII, FIGS. 7-10.

1890. Fenestella conradi Ulrich, Geol. Surv. of Ill., VIII, p. 553, pl. LII, 8, 8a.

1900. Fenestella conradi Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 249.

1902. Fenestella (?) Condra, Amer. Geol., Dec., No. pp. 348, 349, pl. XXI, 3-5.

1903. Fenestella conradi Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium an undulating foliar expansion. Complete zoaria 4 or 5 cm. high. Most specimens collected in Nebraska are fragmentary. Branches strong, more or less roughened on both faces, straight, broad on the obverse, 0.35 to 0.4 mm. wide, ten and one-half in 5 mm. Some young forms show branches less than 0.3 mm. wide, with ten or eleven in 5 mm.

Carina wide, rounded, not very high. The author of the species gave the following: "Carina itself not much elevated, but the rather closely arranged compressed spines which it bears are very strong and exceptionally prominent when perfect."

Dissepiments about as broad as the branches and expanded terminally on the reverse. Branches and dissepiments about equal in size and form, and on a level on the reverse face, where both may show shoulder or knoll-like elevations. Younger specimens have less wide dissepiments. "A small node, perforated at its summit, often occupies the center of the branch at a point midway between the four adjacent fenestrules."

Fenestrules on the reverse, subcircular in form, vary in size with the condition of growth, 0.2 to 0.4 mm. across, with eight to nine in 5 mm.; subelliptical on the obverse, being 0.3 to 0.35 mm. long by 0.15 mm. wide.

Zooecia in two not very regularly disposed ranges. Apertures circular, with two or three, usually two, in each series to the fenestrule, and twenty to twenty-three in 5 mm. Peristome poorly developed.

Occurrence—Coal Measures: Red Oak, Iowa; Southbend, Louisville, Plattsmouth, La Platte, and Nehawka, Nebraska.

The following variety, pronounced by E. O. Ulrich a variety of F. conradi or a closely related species, was published by the writer in the Amer. Geol., 1902, XXX, No. 6, pp. 348, 349, pl. XXII, figs. 3-5, as Fenestella Sp. (?) The specimens are quite unlike typical forms of the species, but seem to show no more than varietal characters. (See Pl. VI, figs. 8-10.)

Zoarium a regular rapidly or slowly expanding net-work. The largest specimen, not complete, is 3.75 cm. high by 2.5 cm.

wide. Branches rigid or flexuous, much the wider on the obverse face, narrowly rounded and thin on the reverse, being 0.16 to 0.24 mm. wide, with nine or ten in 5 mm. Carina quite prominent, thin, varying with the growth, about 0.06 mm. across at the top where it appears sinuous, bearing a row of flattened nodes; nodes 0.1 mm. long by 0.06 mm. wide at the base, 0.2 to 0.3 mm. apart from apex to apex.

Dissepiments on the obverse, not constant in character, about 0.15 mm. wide, depressed, expanded terminally, modifying the fenestrules; on the reverse, slightly smaller, long and without much terminal expansion, on a level with and of the same character as the branches.

Fenestrules on the reverse face, large, elliptical to subquadrate, at times hexagonal, about as wide as long, average 0.4 mm. wide; decrease in width towards the obverse face, where they are usually elliptical, modified by the zooecial apertures, 0.35 mm. long by 0.26 mm. or less wide, with nine or nine and one-half occurring in 5 mm.

Zooecia in two alternating ranges, of medium size. Apertures circular, two to each fenestrule, one placed at the end of each dissepiment with another between, a little more than their diameter apart including the not very definite peristome, project slightly into the fenestrule, eighteen to twenty in 5 mm.

The affinities of these specimens are with F. conradi Ulrich and F. conradi-compactilis Condra. They differ from the former in having about twenty instead of twenty-three zooecia in 5 mm., two instead of two or three apertures to the fenestrule, and a different character of fenestrule. On the reverse face, the branches are relatively much smaller compared with the obverse. The thin keel is also a distinctive feature. They differ from the latter in mode of growth, character of keel, and in having a very different reverse face. Found at Southbend, and Nehawka, Nebraska. The first specimen was collected at Southbend by Professor Erwin H. Barbour, 1896.

Fenestella conradi-compactilis *Condra*

PL. VIII, FIGS. 11, 12.

1902. Fenestella conradi var. compactilis Condra, Amer. Geol., XXX, No. 6, p. 348, pl. XXII, 1, 2.
1903. Fenestella compactilis Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a very thick compact foliar expansion supported by a stalk and root-like processes. The best specimen secured is 4 cm. high by 2 cm. wide; the root-like supports are 1 to 2 mm. in diameter. Branches straight or slightly flexuous, unusually thick from obverse to reverse, close set, quite regular in form and size, average 0.35 mm. wide, 0.4 below and 0.3 mm. immediately above a bifurcation, with nine or nine and one-half in 5 mm.; reverse face smooth, without nodes, slightly smaller than the obverse, but not the difference noted in typical specimens of the species; striations show on the stalk and for a short distance out on the branches, especially when worn. Median carina of the obverse face not very prominent, rounded, straight or slightly flexuous, with small spines or nodes placed in two faint rows.

Fenestrules on the reverse, circular, slightly elliptical in young portions of the zoarium, 0.25 to 0.35 mm. across at the surface, much contracted and nearly obliterated deeper in the frond, eight and one-half or nine in 5 mm., a little longer and less wide on the opposite face.

Zooecia in two alternating ranges. Apertures circular, two and never three to each fenestrule, encroach slightly on the fenestrule, with eighteen in 5 mm.; peristome sometimes well shown, but usually poorly developed.

This variety is about intermediate between F. conradi and F. binodata. The rounded, irregular keel, which at places shows two rows of small nodes, brings to mind the latter. Owing to an omission by the printer, the name appeared in Vol. I of the Nebraska Geol. Survey as Fenestella compactilis. Type specimen No. 18-3-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Southbend, Weeping Water, and Roca, Nebraska.

Fenestella parvipora *Condra*

PL. IX, FIGS. 6-8.

1902. Fenestella parvipora Condra, Amer. Geol., XXX, No. 6, p. 344, pl. XXI, 6, 7.
1903. Fenestella parvipora Condra, Barbour, Nebr. Geol. Surv., p. 127.

Zoarium an expanding foliar net-work of medium size. Branches on the reverse, straight to sinuous, convex, finely striated if worn, more than their own diameter apart, average 0.24 mm. wide, with nine or ten in 5 mm.; bifurcations at distances of 2 to 4 mm. Obverse face subcarinate; the carina is represented by a line on which occur very small nodes; nodes scarcely discernible, 0.04 mm. across at their bases, and 0.15 to 0.21 mm. apart.

Dissepiments straight, long, cylindrical, about one-third as wide as the branches, not much depressed on the reverse face, but depressed on the obverse. Fenestrules oblong, quite large for the size of the branches, average 0.5 to 0.55 mm. long, by 0.31 mm. wide, with seven and one-half in 5 mm.; the narrowest are 0.28 mm. wide.

Zooecia small, in two alternating ranges, with three or four to each fenestrule. Apertures very small, circular, pustuliform with rounded subconial peristomes, 0.09 mm. across including the peristome, face obliquely outward, twice their own diameter apart, twenty to twenty-five in 5 mm.

This species resembles F. spinulosa Condra in having a similar reverse face, but is distinct on account of the number, size and disposition of zooecia. It is not apt to be confused with another member of the genus. F. gracilis Condra has a definite carina with larger spines, larger apertures and very different fenestrules. The writer knows of no other species of the genus with as small zooecia and zooecial apertures.

Type specimen No. 13-18-2-99 in the Morrill Collection in

the museum of the University of Nebraska, Lincoln, Nebraska.
Occurrence—Coal Measures: Roca, Nebraska.

Fenestella subrudis *Condra*

PL. IX, FIGS. 9-11.

1902. Fenestella subrudis Condra, Amer. Geol., XXX, No. 6, pp. 349, 350, pl. XXI, 10, 11.
1903. Fenestella subrudis Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a foliar expansion of unknown size. Branches on the reverse, broadly rounded, granulo-striated, slight sinuous, quite closely approximated, 0.35 to 0.45 mm. wide, with eight in 5 mm.; on the obverse subcarinate, and finished by a small indefinite carina, which may be smooth or bear inconspicuous nodes; carina 0.06 mm. across; nodes, if present, feebly elevated; a flattened area or face extends on each side of the carina down to the broadest part of the branch; these slightly concave areas are modified by the zooecial apertures.

Dissepiments on the reverse, short, wide, expanded terminally, narrowly rounded, not much depressed, and 0.15 to 0.2 mm. wide; they vary more in size and are faintly striated on the opposite face.

Fenestrules elliptical to elongate-elliptical; average on the reverse, 0.5 to 0.55 mm. long by 0.24 mm. wide, slightly larger on the obverse, six in 5 mm.

Zooecia in two alternating ranges. Apertures circular, of medium size, 0.13 mm. across with peristome, a little more than their own diameter apart, including the peristome, three to each fenestrule, seventeen or eighteen in 5 mm. The nearest related species is F. missouriensis Rogers which has a different type of growth.

The writer sent a specimen, as a new species, to E. O. Ulrich, who made the following comment: "Related to F. rudis Ulrich, but more delicate. The present form is practically the same as an abundant Chester species to which I have applied the manuscript name F. subrudis." The writer has used the very sug-

gestive name proposed by Mr. Ulrich. Type specimen No. 7-7-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Chester group, a number of places; Coal Measures: between Weeping Water and Nehawka, Nebraska.

Fenestella gracilis *Condra*

PL. X, FIGS. 6, 7.

1902. Fenestella gracilis Condra, Amer. Geol., XXX, No. 6, pp. 344, 347, pl. XXI, 8, 9.
1903. Fenestella gracilis Condra, Barbour, Nebr., Geol. Surv., I, p. 127.

Zoarium a regular foliar expansion of large size, as indicated by numerous incomplete specimens. Branches on the reverse, about equal in size, straight or slightly flexuous, spread little when bifurcating, appear cylindrical with longitudinal striae, average width 0.25 mm., nine to eleven in 5 mm. The obverse face has a straight carina, 0.07 mm. wide, with rounded summit, bearing a row of small, sharp, conical spines with diameters of 0.07 mm. and placed at distances of 0.22 mm.

Dissepiments slightly expanded terminally, depressed some on each face, slightly on the reverse, 0.1 to 0.13 mm. wide in the middle, wider in older growth. Fenestrules, quite regular in form, subrectangular, vary some in dimensions with different conditions of growth, modified little by zooecial apertures, average 0.65 mm. long by 0.25 mm. wide, long for the width, about six in 5 mm.. A larger form has longer fenestrules.

Zooecia in two alternating straight ranges. Apertures with fairly prominent peristomes, about their own diameter apart, set close in against the carina, facing outward, four and rarely five to each fenestrule, twenty-three to twenty-five in 5 mm. The species resembles F. dentata Rogers, but is not so robust. That species has eight branches in 5 mm., each being 0.4 mm. in diameter; the fenestrules average 0.9 mm. long by 0.3 mm. wide, with four in 5 mm. This species has more and smaller nodes as well as twenty-three to twenty-five instead of eighteen

zooecia, for each range, in 5 mm. The fenestrules are shorter. Type specimens Nos. 2-18-3-00 and 10-18-2-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Roca, Nebraska.

Fenestella kansanensis *Rogers*

PL. X, FIG. 11.

1900. Fenestella kansanensis Rogers, Kans. Univ. Quar., IX., No. 1, pp. 5-6, pl. 5, 6.

1903. Fenestella kansanensis Rogers (?) Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a strong reticulate expansion. Several specimens each 3 or 4 cm. high were collected. Branches robust, cylindrical, striated on the reverse, straight or flexuous, flexures bending to and away from the dissepiments, 0.35 to 0.4 mm. wide, eight in 5 mm. The obverse face has a well-developed, somewhat flexuous carina, 0.1 mm. across, bearing a row of nodes 0.5 to 0.6 mm. apart. Dissepiments expanded terminally, about one-half as wide as the branches. Another form has smaller dissepiments and larger fenestrules, fenestrules subelliptical to subquadrangular, large; average, in typical specimens, 0.8 mm. by 0.4 mm. with nine in 1 cm.

Zooecia large four or five in each range to the fenestrule, seventeen or eighteen in 5 mm.; apertures circular, of medium size, 0.13 mm. across including the peristome, a little more than their own diameter apart, project very little into the fenestrule. Nebraska specimens are more robust than typical. This species is closely related to F. dentata Rogers, and F. burlingtonensis Ulrich. The latter differs in the size of the nodes, but has as many apertures. F. polyporoides is more robust and has three ranges of apertures extending for a short distance below some bifurcations.

Occurrence—Coal Measures: Argentina, and Lawrence, Kansas; Roca, Plattsmouth, Louisville, and Richfield, Nebraska. Specimens found in Nebraska are not typical and are doubtfully referred to the species.

Fenestella polyporoides *Condra*

Pl. X, Figs. 8-10.

1902. Fenestella polyporoides Condra, Amer. Geol., XXX, No. 6, pp. 347, 348, pl. XXII, 6, 7.

1903. Fenestella polyporoides Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a strong reticulate expansion. Several incomplete specimens each 3 or 4 cm. high have been found. Branches robust, usually cylindrical, striated or smooth on the reverse, straight or flexuous, 0.35 to 0.4 mm. wide, 0.5 mm. or more below a bifurcation, five or six in 5 mm. The obverse face has a well-developed carina 0.1 mm. across; it is somewhat flexuous, and usually bears a row of large nodes 0.5 to 0.6 mm. apart. Dissepiments expanded terminally, about one-half as wide as the branches. One form has smaller dissepiments and larger fenestrules; fenestrule subelliptical to subquadrangular, large in typical specimens, 0.9 to 1.25 mm. long by .45 to 0.6 mm. wide inside measurement, with seven or eight in 1 cm.

Zooecia large, in two or three ranges, often three for a short distance below a bifurcation, four to six in each range to the fenestrule, seventeen or eighteen in 5 mm.; apertures subcircular, 0.14 mm. across including the peristome, a little more than their own diameter apart, project very little into the fenestrule.

The species is related to F. kansanensis Rogers and F. dentata Rogers; F. burlingtonensis Ulrich differs in the size of nodes, but has as many apertures in each series within a given space. Specimens sent to E. O. Ulrich were pronounced by him members of the genus Polypora. However, the writer is inclined to place them with Fenestella. The main specific characters are found in the resemblance to the Polyporae and in the large dimensions.

Some zoaria are quite diffuse in growth, while others have long, straight branches. Specimens collected at Nehawka most closely resemble the Polyporae; in them the branches are quickly rounded on the reverse, and three ranges of zooecia extend for a greater distance than in other specimens referred

to the species. Type specimens Nos. 8-14-3-03 and 6-12-5-01 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Roca, Plattsmouth, and Nehawka, Nebraska.

Fenestella binodata *Condra*

PL. X, FIGS. 12, 13.

1902. Fenestella binodata Condra, Amer. Geol., XXX, No. 6, pp. 350, 351.

1903. Fenestella binodata Condra, Barbour, Nebr. Geol. Surv., 1, p. 127.

Zoarium a reticulate expansion of unknown size. No complete zoaria have yet been found; one nearly complete is 3 cm. high; another specimen shows the zoarium at its inception, where the numerous bifurcations give it a rapid expanse. Fragments from farther out in the frond have straight or flexuous loosely approximated branches. Branches, on the reverse, slightly flexuous in the older parts, nearly straight in the periphery, stout, rounded, finely striated or smooth; deep from the reverse to the obverse face, 0.35 to 0.4 mm. wide, on the obverse with six to eight in 5 mm. Carina a blunt ridge, 0.1 to .14 mm. across, bearing two rows of conical or laterally compressed nodes alternately placed; nodes at their bases, 0.1 mm. long, 0.06 mm. wide, placed 0.27 mm. apart from apex to apex in each series and 0.15 mm. distant from the nearest node or spine in the alternating series.

Dissepiments on the reverse, of the same character as the branches, expanded terminally, slightly elevated or depressed, average 0.2 mm. wide and 0.22 long, slightly less wide and faintly striated on the opposite face.

Fenestrules usually subelliptical to oblong, vary in size, about the same in size and form on both faces, slightly modified by zooecial apertures, 0.6 to 0.7 mm. long by 0.35 mm. wide, six or six and one-half in 5 mm.

Zooecia in two subalternate ranges, not laterally disturbed as

with F. conradi Ulrich. Apertures circular, with thin peristomes on the side facing the fenestrule, inner border set in against the carina with the apertures facing out or obversely, three or four to each fenestrule, may or may not be plaeed at the ends of the dissepiments, eighteen to twenty in 5 mm. What may be a variety has smaller dimensions.

This species, though related to F. ovatipora Rogers, which has a raised area and no spines, is very distinct. Rogers' species has ovate apertures, four to each fenestrule, with four fenestrules in 5 mm. This species is nearer F. conradi-compactilis Condra, which may have a slightly binodate appearance, but is distinct on account of the character and number of apertures to the fenestrule, the longer fenestrules, and the more definite binodate arrangement of larger nodes; the reverse faces are very dissimilar. There is some resemblance to F. remota Foerste, which has a more regular and finer growth, a less binodate appearance and a larger number of apertures in a given space. F. subrudis Condra resembles in general measurements, but is otherwise very different. The principal characters of this species are found in the double row of alternating nodes on a broad carina, and in the comparatively robust appearance. Type specimen No. 32-16-7-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Southbend, Louisville, Cedarcreek, Weeping Water, and Roca, Nebraska.

Polypora *McCoy*

1845. Polypora McCoy, Synopsis Carboniferous Fossils, Ireland, p. 206. See Nickles and Bassler in Bull. 173, U. S. G. S., pp. 357-358, 1900, for bibliography.

Zoarium as in Fenestella, but with more ranges of zooecia; two to eight series occur on each branch, if two, for a limited distance only; median carina lacking or poorly developed

Genotype: Polypora dendroides McCoy. Range, Silurian-Permian. Some specimens grouped under this genus are very closely related to Fenestella. Two varieties of P. elliptica

Rogers show a definite carina where two ranges of zooecia occur. The following species and varieties represented in this state are herein described: P. spinulifera Ulrich, P. elliptica Rogers, P. bassleri Condra, P. reversipora Condra, P. ulrichi Condra, P. cestriensis Ulrich, P. stragula White, P. submarginata Meek, P. crassa Ulrich, and P. remota Condra.

The most common and representative species are P. elliptica, P. submarginata, P. bassleri, and P. ulrichi. Two specimens of P. whitei were collected at Louisville.

Polypora spinulifera *Ulrich*

PL. XI, FIGS. 1-3.

1890. Polypora spinulifera Ulrich, Geol. Surv. Ill., VIII, p. 598, pl. LXI, 2, 2a, 3, 3a, 4, 4a.
1894. Polypora spinulifera, Keyes, Missouri Geol. Surv., V., p. 30.
1900. Polypora spinulifera Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 368.
1901. Polypora spinulifera (?) Rogers, Kans. Univ. Quar., IX, No. 4, p. 252.
1903. Polypora spinulifera Ulrich, Barbour, Nebr. Geol. Surv., 1, p. 127.

"Zoarium a foliar fan-shaped, undulated or flat expansion 4 or 5 cm. in height." Nebraska specimens vary more in dimensions than with typical specimens. Branches, on the reverse, straight in their general course, quickly rounded, with flattened sides, smooth or finely granulose, 0.3 mm. or more wide near the surface; on the obverse they are gently convex, 0.5 to 0.7 mm. across, carrying numerous small spines, with six branches in 5 mm. Dissepiments on a level with and resemble the branches on the reverse; shorter, convex and depressed on the obverse; not very different in width on the two faces. Fenestrules on the reverse, oval, subcircular, sometimes hexagonal; averaging 0.5 to 0.75 mm. long by 0.3 mm. wide.

Zooecia in three to six, commonly four, alternating ranges. If the number is three or six, it is for a short distance above or

below a bifurcation. Two ranges may occur just above a bifurcation. Apertures circular, of medium size, 0.09 to 0.1 mm. in diameter, more than their own diameter apart, four and rarely five in each range to the fenestrule. Spines on the obverse, small, about 0.05 mm. in diameter, distributed regularly or irregularly among the apertures which they about equal in number; the spines are of specific importance and serve as a basis for the name. Very few typical specimens are found in the state. Smaller forms are quite like certain specimens of P. elliptica Rogers, while more robust examples grade into P. bassleri Condra.

Occurrence—Chester Group: Chester, and Monroe counties, Illinois; Coal Measures: Montgomery county, Illinois; Red Oak, Iowa; Tablerock, Dawson, Southbend, Louisville, La Platte, and Nehawka, Nebraska.

Polypora elliptica *Rogers*

PL. XI. FIGS. 4-11; PL. XII, FIGS. 1-13: PL. XVI, FIG. 3.

1900. Polypora elliptica Rogers, Kans. Univ. Quar., IX, No. 1, p. 7, pl. IV, 2.

1902. Polypora elliptica Rogers, Kans. Univ. Quar., IX, No. 4, pp. 233, 240, etc.

1903. Polypora elliptica Rogers, Barbour, Nebr. Geol. Surv., I, p. 127, pl. II, 8.

This is the best represented species of the genus found in Nebraska. For that reason, as well as for the purpose of further delineation, each type of growth is herein briefly described. The author of the species gave the following description:

"Zoarium a reticulate expansion. Branches slightly flexuous, convex, 0.4 to 0.5 mm. wide, seven to eight in 5 mm. Dissepiments subcarinate, about half as wide as the branches. Fenestrules elliptical (especially in worn specimens), averaging about 0.6 by 0.3 mm. with from four to six occurring in 5 mm. Zooecia in three or four alternating ranges, which number is often reduced to two for a very short distance after bifurcation. The typical number of ranges is three when the central row forms

the flat median summit of the branch. In this case the number is increased to four shortly before bifurcating. Apertures small, subcircular, about one and one-half times their diameter apart longitudinally. The rows of apertures are separated by inconspicuous undulating ridges, which are at intervals elevated to form small nodes, about as numerous as the apertures. The ridges are more conspicuous in worn specimens. On the reverse the dissepiments and the branches are on the same plane. The latter are finely striated."

The writer has spent much time studying this species with the intermediate forms. Correspondence with Mr. Rogers, who kindly furnished type specimens for comparison, has greatly assisted me in a fuller understanding of the species. Specimens received from Mr. Rogers are thought to be identical with those represented on Pl. XI, figs. 4-9, to which the writer had given the manuscript name P. spinulifera var. aequalis before Mr. Rogers published his paper. The zoarium is a large fan-shaped expansion, the largest example seen by me being over 10 cm. high. Branches small, straight to slightly flexuous, six or seven in 5 mm., vary in size and form in different growths, closely placed in old growth, less close and straight when young, poriferous face evenly convex with a few small spines, reverse of young specimens striated; bifurcations far apart; spines small, fewer in number than in P. spinulifera Ulrich. Dissepiments thin or thick depending on the growth. Fenestrules vary in form and size with growth, elliptical in young and subcircular on the reverse face of old specimens; zooecia in three to five, sometimes two, alternating ranges. Three ranges continue for a considerable distance on young branches.

The reverse face of the old condition (Pl. XI, figs. 5, 7) resembles quite closely that of F. conradi Ulrich with which it is easily confused when the obverse is not exposed. In some specimens collected at Louisville, where an impure limestone is literally covered by these fossils, the apertures are quite concealed by a calcareous deposit.

This variety seems to be quite the same if not identical with that figured by Ulrich, 1890, in the Geol. Surv. of Ill., Vol.

VIII, pl. LXI, figs. 3, 3a. It is now thought by the writer' that these specimens belong with P. elliptica rather than with P. spinulifera and that they do not typically represent the species.

Specimens farther removed from Ulrich's species and without doubt distinct are shown on Pl. XII, figs. 1-4. The growth begins much as it does in the specimens already described but becomes quite different in old growth which is modified on the obverse face by mastoid-like nodes fully as large as those found in P. nodocarinata Ulrich. Nodes small in young specimens, large in old, less numerous, and larger than in P. spinulifera, elevated from poorly defined longitudinal ridges, frequently prominent enough to modify the zooecial apertures and peristomes. Fenestrules and dissepiments vary with the growth about as in specimens already described. Six or seven branches occur in 5 mm. A blunt carina may be found where two ranges of zooecia occur. Zooecia in two to five ranges with three or four apertures in each range to the fenestrule. Mr. Rogers mentioned the relation which these nodate specimens bear to P. nodocarinata. Specimens found at Roca, Southbend, and Tablerock.

Figs. 5-13 of Pl. XII represent a variety (formosa). The specimens are more unlike those already described. They begin and end differently in growth. Zoarium usually more delicate and diffuse. Branches and dissepiments generally in the same plane and narrowly rounded on the reverse, broadly convex on the obverse face; in old growth, less narrow and closely placed. Fenestrules subquandrangular to subcircular on the reverse. Zooecia and apertures small; peristome thin, usually incomplete. The relations are with P. whitei; at least the development is in that direction. Found at Tablerock and Southbend.

Figs. 10 and 11 of Pl. XI show specimens identified by Mr. Rogers as P. elliptica. They are yet more unlike typical specimens of the species and may be characterized as follows: Branches thick from reverse to obverse, straight to flexuous, quickly to evenly rounded and faintly granulose on the reverse, five or six, sometimes seven, in 5 mm., subcarinate on the

obverse, bearing a carina where there are two ranges of zooecia. Carina 0.09 mm. across, rounded, variable in extent, usually longer than in other specimens belonging to the species, carrying small nodes 0.25 to 0.35 mm. apart; nodes in one or two rows where there are three ranges of zooecia, in one row along the center of the branch where four, five, and sometimes six ranges occur. Dissepiment wide, short, very little too much depressed on the obverse, resemble the branches on the reverse. Fenestrules oblong with four or five in 5 mm. Zooecial apertures circular, with four or five in each range to the fenestrule; peristome well elevated.

The carinate specimens are quite readily identified. Found at Tablerock, and between Weeping Water and Nehawka.

Occurrence of the Species—Coal Measures: "Kansas City, Missouri; Argentina, Lawrence and Topeka, Kansas;" Tablerock, Tecumseh, Roca, Ashland, Southbend, Louisville, Cedarcreek, LaPlatte, Rockbluff, Weeping Water, and between Weeping Water and Nehawka, Nebraska. Permian: Blue Springs, Nebraska. The first specimens described, or those closely related to P. spinulifera, are abundantly found at Louisville where they mark a very distinct horizon in the big quarry below town. Variety formosa, as it is designated on account of the subtriangular branches and rhombic fenestrules in young specimens giving a characteristic form, is well represented at Tablerock and occurs at Southbend. Carinate specimens are found at Tablerock, and between Weeping Water and Nehawka. The nodate specimens which are thought to typically represent this composite species, occur at Roca, Tablerock, and Southbend.

Polypora bassleri *Condra*

PL. XIII, FIGS. 8-10; PL. XVI, FIGS. 1, 2.

1902. Polypora bassleri Condra, Amer. Geol., XXX, No. 6, p. 351, pl. XXII, 8, 9; pl. XXIII, 1.

1903. Polypora bassleri Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium expanding to regular in growth, of medium size.

Branches vary considerably in form and size, 0.7 to 1 mm. wide below a bifurcation, four or five in 5 mm., irregular to straight in extent, narrowly or evenly rounded on the reverse face, resembling, when narrow, P. submarginata Meek; form on the poriferous face, usually convex but varying from broadly convex to to subcarinate. Spines generally small, scattered over the surface as in P. spinulifera Ulrich or placed in a row along the center of the branch, sometimes located on thin zigzag lines or ridges which, when present, extend vertically between the ranges of zooecia. Dissepiments long, expanded terminally, broadly rounded and one-half to about as broad as long on the obverse, resemble the branches or appear somewhat depressed and contracted in the middle on the opposite face. Fenestrules elliptical to oblong, relatively large, 0.9 to 1 mm. long by 0.45 mm. or more wide on the obverse, four in 5 mm., larger on the opposite face of the irregular growth. Zooecia in three to six, sometimes seven, alternating ranges; ranges or series closely placed on some branches. Apertures circular, 0.11 mm. or more across, about one and one-half diameters apart, nineteen or twenty in 5 mm., five, rarely four, sometimes six, in each range to the fenestrule. Peristomes developed on part or all of the apertures, usually around the lateral apertures, often not shown on central ranges where the surface is modified by vertical ridges.

The above description covers this comprehensive species as formerly outlined but not very clearly defined by the writer. Specimens of the species differ more than usual to be placed under one name. However, the writer, after a careful study of typical specimens (the diffuse growth) and intermediate forms, found them all specifically related. The expanding or diffuse growth resembles P. submarginata Meek on the reverse. The growth is coarser than in P. spinulifera Ulrich, showing larger fenestrules, wider branches, and longer dissepiments. On the poriferous face, the branches usually appear quite rough on account of spines and ridges.

Specimens collected at Nehawka, and Weeping Water resemble P. approximata, with growth fully as regular and robust.

The fenestrules average larger; the spines are scattered or occur in a row along the center of the branch.

The species in general, is a composite of coarse P. spinulifera and P. approximata, and varies in growth, one form of which resembles and may be confused with the reverse face of young P. submarginata Meek.

The name was given in honor of Mr. R. S. Bassler, who has rendered the writer valuable assistance. Type specimes No. 9-11-7-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Southbend, La Platte, Louisville, Cedarcreek, Weeping Water, and between Weeping Water and Nehawka, Nebraska. The species in the irregular growth, is most plentifully found in the quarry just below Louisville, occurring in thin beds of limestone above the Polypora elliptica horizon.

Polypora reversipora *Condra*

PL. XII, FIGS. 14-17.

1902. Polypora reversipora Condra, Amer. Geol., XXX, No. 6, pl. XXIII, 2-5.

1903. Polypora reversipora Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a flat foliar expansion of large size. Branches on the reverse, stout, flexuous, bending into and away from the dissepiments, narrowly or slowly rounded with sides facing the fenestrules flattened; reverse face covered with granules 0.05 mm. across and a few circular accessory pores; accessory or reverse pores usually 0.14 mm. in diameter, placed near the ends of the dissepiments, but in some specimens scattered over the surface. Branches close, average .07 to .08 mm. wide, .09 mm. just below a bifurcation with five in 5 mm.; obverse face quickly rounded, with large nodes along the center which cause it to appear thin; nodes readily observed by the unaided eye, irregular in form and size, 0.15 mm. wide by .03 mm. long at their bases, elevated, .04 to .05 mm. apart from apex to apex, in one regular row in young specimens, or in irregular rows in old forms.

Dissepiments on the reverse, short, granulose; much depressed and thinner on the opposite face. Fenestrules of the reverse, elliptical, 0.9 mm. long by 0.5 mm. wide, smaller deeper in the frond; on the obverse face, less regular, longer, narrower, 1 to 1.1 mm. long by 0.3 to 0.4 mm. wide, four in 5 mm.

Zooecia in four or five, sometimes six, alternating ranges. Apertures subcircular, 0.9 to 0.11 mm. across, about one and one-half diameters apart; lateral ranges with thin incomplete peristomes; the middle ranges are quite obscured by the large nodes while the lateral ranges are not easily seen on account of the depth and the flattened surface. No Coal Measure species has the apertures more obscured; sixteen occur in 5 mm., with four in each range to the fenestrule.

This species is related to F. ulrichi Condra but is less robust and structurally different. The accessory pores of the reverse face serve as the basis for the name. Type specimen No. 13-1-8-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Tablerock, Nebraska. The first specimen of the species was collected by Mr. W. H. H. Moore, 1900.

Polypora ulrichi *Condra*

PL. XIII, FIGS. 1-7.

1902. Polypora ulrichi Condra, Am. Geol., XXX, No. 6. pp. 352, 353, pl. XXIII, 6-10.

1903. Polypora ulrichi Condra, Barbour, Nebr. Geol. Survey, I, p. 127.

Zoarium a reticulate expansion of large size. Branches somewhat irregular in extent, average 0.9 mm. wide, 1.20 mm. below and 0.65 mm. immediately above a bifurcation, seven or eight in 1 cm.; reverse face convex, at times narrowly rounded, granulose; obverse, frequently granulose, subcarinate, especially in young unworn specimens, bearing large nodes. Nodes irregularly placed along the middle of the branch or somewhat scattered, cylindrical, sometimes irregular in form especially in the

old growth, 0.15 to 0.21 mm. in diameter, larger when old. Dissepiments usually much depressed, subcarinate and short on the obverse; longer, some wider, stout, expanded terminally, little and sometimes not all depressed, and faintly granulose on the reverse.

Fenestrules on the reverse, subelliptical, 1.15 to 1.30 mm. long by .04 to .05 mm. or more wide, six to seven in 1 cm.; not quite so long on the reverse. Zooecia large, in four to seven alternating ranges, usually five or six, six or seven just below, and three or four for a short distance above a bifurcation. Apertures small, circular, with thin, sharp, peristome usually incomplete on the lower and inner margins, fully twice their own diameter apart, sixteen or seventeen in 5 mm., generally five in each range to the fenestrule.

This species is more robust than P. nodocarinata Ulrich. It has larger and fewer nodes which are not distributed as they are in that species. The zooecial apertures are of a different character. The subcarinate appearance of the branches on the obverse calls to mind P. submarginata Meek, though the two species are very distinct. P. bassleri Condra is less robust but resembles some in the disposition of zooecia and to a degree on the reverse face. Type specimen No. 15-1-8-00 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska. A variety has smaller dimensions, with branches and fenestrula not much larger than in P. nodocarinata Ulrich and P. approximata Ulrich. In fact the variety, for the most part, seems to combine the distinctive characters of those species, but has larger nodes and sharp incomplete peristomes. It differs from one form of P. bassleri by having incomplete peristomes, larger nodes, and a somewhat different type of growth.

The name of this well-represented species was given in honor of E. O. Ulrich, the American authority on Paleozoic bryozoa, whose literature and other assistance have been of inestimable value to the writer.

Occurrence—Coal Measures: Tablerock, Falls City, and Ben-

nett, Nebraska. The first specimen of the species was collected by Miss Carrie A. Barbour, at Tablerock, 1900.

Polypora cestriensis Ulrich

PL. XIV, FIGS. 5, 6.

1890. Polypora cestriensis Ulrich, Geol. Surv. Ill., VIII, p. 594, pl. LV, 4-4s, pl. LX, 7-7c.
1894. Polypora cestriensis, Keyes, Missouri Geol. Surv., V, p. 29.
1900. Polypora cestriensis Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 360.
1903. Polypora cestriensis Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

According to Mr. Ulrich, the single specimen found in this state represents a variety with a more regular growth than typical. The following description is based on the specimen found here. Branches on the reverse, subcarinate, where small, evenly rounded, where large, surface striated, average diameter 0.6 to 0.65 mm., 1 mm. below and a little over half as wide immediately above a bifurcation, four or five in 5 mm.; obverse face subcarinate to quickly rounded bearing a central row of sharp nodes 0.3 to 0.6 mm. apart. Dissepiments slender, fairly large, expanded terminally, widest midway between the two faces, on a level with the branches on the reverse, striated and depressed on the obverse. Fenestrules on the reverse, subovate, relatively large, 1.4 to 1.5 mm. long by 0.5 to 0.6 mm. wide, over 1 mm. long by 0.4 mm. wide inside measurement, three in 5 mm.

Zooecia in three to six or seven alternating ranges, six or seven before, and three immediately above a bifurcation; the usual number is five. Apertures circular, pustuloid, small, 0.08 mm. in diameter, twice their own diameter apart longitudinally including the peristome, usually five and rarely four to the fenestrule, fifteen in 5 mm. Peristome complete, elevated. See Ulrich's description in the Survey of Illinois.

"Occurrence — Chester Group: Chester, Kaskaskia, near Anna, and other localities in Illinois; also at Litchfield and Sloan's Valley, Kentucky." Coal measures: Tablerock, Nebraska.

Polypora stragula *White*

1866. Polypora biarmica (not of Keyserling), Geinitz, Carb. und Dyas in Nebraska, p. 28.
1872. Polypora, Undet. Sp., Meek, Pal. Eastern Nebraska, p. 155.
1874. Polypora stragula White, Prelim. Rep. Invert, Foss, p. 19.
1877. Polypora stragula White, Wheeler's U. S. G. S., IV, p. 108, pl. VII, 4a, b.
1900. Polypora stragula White, Nickles and Bassler, Bull. 173, U. S. G. S., p. 369.
1903. Polypora stragula White, Barbour, Nebraska Geol. Surv., I, p. 127.

As yet, the writer has not found any undoubted specimens of this species. A few poorly preserved specimens found at Nehawka probably belong here. The following is an abstract from White's description: Zoarium apparently flabelliform. Branches in general course straight, sagged on the sides facing the fenestrule; bifurcations at regular intervals. Dissepiments expanded terminally, about one-half as wide as the branches. Fenestrules oval or oblong, varying in size and form in different portions of the zoarium, one and one-fourth to two times as long as wide, with three in 5 mm. Zooecia in four to six not very regular vertical ranges; oblique ranges more definite. Apertures small, of uniform size, and close set." The figures are not copied, as they seem to have been drawn with little care.

Occurrence—Carboniferous: White Mountains, Arizona, (White); Upper Coal Measures, Nebraska City, Nebraska, (Meek).

Polypora submarginata *Meek*

PL. XIV, FIG. 7; PL. XVI, FIGS. 4-7.

1866. Polypora marginata (not McCoy), Geinitz, Carb. und Dyas in Nebraska, p. 69, pl. V, 11a, b, 12a, b.
1872. Polypora submarginata, Ulrich, Geol. Surv. Ill., VIII, p. 602, pl. LXI, 6-6b.

1894. Polypora submarginata, Keyes, Missouri Geol. Surv., V, p. 30.
1900. Polypora submarginata Meek, Nickles and Bassler, Bull. 173 U. S. G. S., p. 369.
1903. Polypora submarginata Meek, Barbour, Nebraska Geol. Surv., I, p. 127.

Zoarium a flabellate to an infundibuliform expansion, springing from a thin subcircular support varying in size. Frequent bifurcations give rise to a fenestrated frond which has a tendency to be incompletely funnel-shaped. Zoarium large, sometimes 5 cm. or more high, poriferous on the inside. The specimens seem to vary too much to all be included under one name. Some approach P. distincta Ulrich in length of fenestrule and in the number of ranges of zooecia. Perfect branches subpentagonal in cross section, the two lateral margins being sharply angular; the course is irregular near the stalk, but more regular in the periphery. Branches average 1 mm. wide, with six or seven in 1 cm; reverse face narrowly rounded, with flattened sides, smooth or with many fine longitudinal striae; obverse face, if perfect, subcarinate, carrying a row of conical nodes along the middle; nodes, averaging 0.3 mm. apart, alternate with the apertures of the central row of zooecia.

Dissepiments from one-half as wide to equal the branches in width, narrow to subcarinate on each face, of the same character as the branches on the reverse, expanded terminally, depressed on the obverse. Fenestrules oblong-oval, not very different in size on the two faces, wider on the reverse where they are 2 mm. long by 0.8 to 1 mm. wide with four or five in 1 cm. Zooecia in five to seven or eight not very regularly alternating ranges, usually five, with six, seven or eight for a short distance below, and three or four immediately above a bifurcation. Apertures circular, with more or less distinct peristomes, six to eight to the fenestrule, 0.11 to 0.12 mm. in diameter, two diameters or more apart, fourteen to seventeen in 5 mm.

The reverse face of this species may be confused with P. crassa Ulrich, but is more delicate and has narrowly rounded instead of broadly convex branches. Specimens collected at

Peru, Nebraska, have only five or six ranges of zooecia below a bifurcation with four ranges between bifurcations; also the branches are more slender.

Occurrence — Coal Measures: Macoupin county, Illinois; LaSalle, and Springfield, Illinois; Red Oak, Iowa; LaPlatte, Louisville, Southbend, Cedarcreek, Tablerock, Dawson, Falls City, Peru, Rockbluff, and Bennett, Nebraska. This is one of the common and at places abundant species of the state.

Polypora crassa Ulrich

PL. XIV, FIGS. 3, 4; PL. XV, FIG. 1.

1890. Polypora crassa Ulrich, Geol. Survey, Ill., VIII, p. 103, pl. LXI, 8, 8a.

1900. Polypora crassa Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 361.

1903. Polypora crassa Ulrich, Barbour, Nebr. Geol. Surv.,. I, p. 127.

Zoarium a rapidly expanding fan-shaped network of large size. One complete specimen well preserved (Pl. XV) collected at Weeping Water by Mr. E. G. Woodruff, is 9 cm. high and 8 cm. wide. Branches coarse, tortuous, slowly rounded on the reverse face, convex on the obverse, average width over 1 cm., five or six in 1 cm.; bifurcations at short intervals near the support, less frequent in the periphery. Specimens found here are larger and better preserved than were those from which the species was first described; the fenestrules are larger. Type specimens have fenestrules 2.4 mm. long by 0.7 mm. wide with three and one-half in 1 cm.

Dissepiments vary in length, long or short, on a level with and resemble the branches on the reverse, except that they are usually thinnner and more quickly rounded.

Fenestrules irregular-oblong, usually as wide or wider than the branches, vary from 2 to 4 mm. long, average 2.6 mm. long by 1.1 mm. wide, three in 1 cm.

Nebraska specimens do not show the obverse face; sections reveal much of the following taken from Ulrich's description.

Zooecia in from four to eight ranges. Apertures circular, arranged in more or less diagonally intersecting series in which four occur in the space of 1 mm. longitudinally; about eleven occur in 3 mm. The zooecial apertures usually do not extend to the margin of the branch.

Occurrence—Coal Measures: Sugar Creek, Sangamon county, Illinois; Nehawka, Weeping Water, Ashland, Louisville, Southbend, Plattsmouth, Tablerock and Falls City, Nebraska.

Polypora remota *Condra*

PL. XIV, FIGS. 1, 2.

1902. Polypora remota Condra, Amer. Geol., XXX, No. 6, pp. 352, 353, pl. XXIV, 1, 2.

1903. Polypora remota Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium an evenly spreading network, 3 cm. high by 2 cm. wide, growing from a small stalk. Branches cylindrical, about their own diameter apart, evenly convex on both faces, smooth except for the zooecial apertures and fine striae, loosely joined, bifurcating at regular intervals of 5 mm. or more, branches, 0.7 mm. wide, 1 mm. wide just below a bifurcation, seven in 1 cm.

Dissepiments, thin, cylindrical, depressed on each face, few in number, pass direct or at an angle from one branch to the other, averaging 0.25 mm. wide.

Fenestrules few, long, not very different in size and form; by inside measurement they are 2.5 mm. long by 0.7 to 0.8 mm. wide; three to three and one half occur in 1 cm.

Zooecia in four to six alternating ranges. The usual number is five, with six before, and four immediately above a bifurcation; apertures circular, small, 0.08 to 0.10 mm. across, 0.13 mm. across including the peristome, pustuloid with peristome, three to five times their own diameter apart longitudinally, five or six to the fenestrule, twelve to thirteen in 5 mm.

This species is not far removed from the genus Thamniscus, the bifurcations being about one-half as numerous as the dissepiments. Polypora gracilis Prout seems to be the closest related

species. That species has a less regular growth and nine instead of twelve or thirteen apertures in 5 mm. Also, it has spines while this species is smooth. P. triangularis Rogers is thought to be quite distinct. Specimens collected at Falls City and doubtfully placed here show stouter dissepiments, a less diffuse growth, and apertures more closely placed. The very thin and slender dissepiments are of specific importance. No other Coal Measure Polypora of as large dimensions has dissepiments so thin. The name is given on account of the distance the apertures are apart in the series. Type Specimen No. 2-20-7-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence — Coal Measures: Louisville, Cedarcreek, Falls City (?), Nebraska.

Thamniscus *King*

1848. Thamniscus King, Ann. Mag. Nat. Hist., Ser. 2, II, p. 389. See Nickles and Bassler, Bull. 173, U. S. G. S., p. 427, 1900, for bibliography.

"Zoarium as in Polypora, but branches bifurcate more frequently and are rarely, or not at all, connected by dissepiments." The genus is very closely related to Polypora, but is distinguished by the usual absence of dissepiments. Zoaria pinnate, palmate, or bifurcate. Represented in the Coal Measures of America by five species. The following occur in this State: T. pinnatus Condra, T. sevillensis Ulrich, and T. palmatus (Provisional) Condra.

Genotype: Ceratophytes dubius Schlotheim. Range, Silurian-Permian.

Thamniscus pinnatus *Condra*

PL. XVII, FIGS. 1-5.

1902. Thamniscus pinnatus Condra, Amer. Geol., XXX, No. 6, p. 354, pl. XXIV, 3-8.

1903. Thamniscus pinnatus Condra, Barbour, Nebr. Geol. Surv., I, p. 128.

Zoarium a pinnate frond, varying much in size; one complete specimen collected at Roca is 3 cm. high, and 4 cm. wide; all other zoaria found are smaller and average higher than wide; the base is subcircular, from which a stalk ascends to support the frond. The main branch ascends in a zigzag manner, giving off short pinnae or lateral branches at the bends and bifurcates at distances of from 4 to 10 mm. Another form of growth is less zigzag in character. It is more like T. octonarius Ulrich, but has been pronounced distinct by the author of that species. Branches subcircular to subelliptical in section, wider than thick, especially at a distance from the stalk, 1 or, 2 mm. wide, more than their own diameter apart; form and size vary in different regions and with the condition of growth; the obverse face is more convex than the reverse. "The pinnate branches divide, with rounded angles. Pinnae alternately placed, about 2 mm. apart on each margin of the branch, 1 mm. apart longitudinally along the branches between the bifurcations, usually about 1 to 1.5 cm. long.

Zooecia increase rapidly in number of ranges, from three, four or five, to seven or eight, and infrequently nine, between the bifurcations. Apertures small, 0.07 mm. in diameter, circular, pyriform in worn specimens, arranged in definite longitudinal series and quite regular diagonal series; fifteen occur in .5 mm. longitudinally, four and one-half in 1 mm. diagonally; in some well preserved specimens they are placed on faint oblique ridges."

The branches divide with rounded angles, but the ranges of zooecia separate at acute angles with a wedge-shaped area between. Peristome, in perfect specimens, horseshoe-shaped, elevated, lifted into a small spine on each side of the aperture. On the lower side of the aperture the peristome widens to wholly or partially surround a sub-oval depression which, in perfect specimens, is .14 mm. wide by .18 mm. long.

This species is related to T. octonarius Ulrich, but has more prominent apertures and a pinnate instead of a bifurcate zoarium. The figures represent two types of growth and what may be two distinct species, yet the writer prefers, for the present at

least, to place them under the same name. One form is less pinnate and more like Ulrich's species. Type specimen No. 18-18-2-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Bennett, Roca, Falls City, Southbend, and Dawson, Nebraska. A common fossil in certain beds two miles below Bennett.

Thamniscus sevillensis *Ulrich*

PL. XVII, FIG. 6.

1890. Thamniscus ramulosus Ulrich, Geol. Surv. Ill., VIII, p. 610, pl. LXII, 4-4b.

1890. Thamniscus ramulosus var. sevillensis Ulrich, Geol. Surv. Ill., pp. 610, 611, pl. LV, 6, pl. LXII, 5, 5a.

1903. Thamniscus sevillensis Ulrich, Barbour, Nebraska Geol. Surv., I, p. 128.

Later, Mr. Ulrich raised the variety sevillensis to the importance of a species. One single well-preserved specimen found at Roca represents a variety with the following description:

Zoarium a rapidly expanding frond, about 1 cm. high by 1.5 cm. wide. Branches rounded on the reverse, 0.35 to 0.65 mm. wide, depending on the position in the zoarium from which the measurements are taken; they gradually decrease in size towards the periphery; bifurcations with wide angles, at distances of 1 to 2 mm., giving a diffuse appearance to the zoarium. A row of small conical nodes is scattered along the centers of the branches on the reverse side at distances of 0.5 to 0.7 mm.; some few reverse pores occur at distant intervals on this face.

In the periphery, pinnae or small branches are given off subalternately, right and left, from the sides of the branches at distances of 0.6 to 0.7 mm.

Zooecia, as determined from worn portions of the reverse face, in three to four alternating ranges; apertures more than three times their diameter apart longitudinally, with fourteen or fifteen in 5 mm. This variety has a more diffuse growth than typical specimens of the species.

Thamniscus palmatus (Provisional) *Condra*

PL. XVII, FIG. 7.

1902. Thamniscus palmatus (Provisional) Condra, Amer. Geol., XXX, No. 6, p. 355, pl. XXIV, 9.

1903. Thamniscus palmatus (Provisional) Condra, Barbour, Nebr. Geol. Surv., I, p. 128.

Zoarium a small palmate expansion, 11 mm. wide and 12 mm. high, supported by a circular base from which ascends a short dividing stalk which divides into primary and secondary branches; branches about 0.65 mm. wide, quite straight, evenly convex, nearly in a plain, about their own diameter apart, bifurcate with rounded acute angles; no dissepiments or fenestrules present.

Zooecia extend from the sides of the branches and seem to show prominent projecting apertures, 0.21 to 0.25 mm. apart, with thirteen occurring in 5 mm. Worn portions of the zoarium show them arranged in three to five ranges. Owing to its mode of growth, no other described bryozoan is apt to be confused with this species. As yet only one specimen has been secured. It was sent to E. O. Ulrich, who pronounced it of strange and peculiar growth, and expressed his regrets that the obverse face did not show. Type specimen No. 30-5-99 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Roca, Nebraska.

Acanthocladiidae *Zittel*

"Zoarium a pinnate or fenestrate expansion, celluliferous on one face only, consisting of strong central stems which give off numerous smaller, lateral branches from their margins; the lateral branches are free, or unite with those of the next stem; nonporiferous dissepiments rarely present; zooecial characters mostly as in the Fenestellidae." The family is usually distinguished from Fenestellidae by the presence of apertures on the dissepiments or lateral branches. Represented in this state by two genera: Pinnatopora Vine and Septopora Prout.

Pinnatopora *Vine* (*Glauconome of some authors*)

"Zoarium a small delicate stipe, with short, free, lateral branches given off frequently and at regular intervals; apertures in two rows separated by a moderate median keel." Genotype: Glauconome elegans Young and Young. Range, Devonian—Coal Measures. The following species were found in the state: P. trilineata (Meek), P. pyriformipora Rogers, and P. youngi Ulrich.

Pinnatopora trilineata (*Meek*)

PL. XVII, FIG. 8.

1872. Glauconome trilineata Meek, Pal. Eastern Nebraska, p. 157, pl. VII, 4 a-d.
1890. Pinnatopora trilineata Ulrich, Geol. Surv. Ill., VIII, p. 620, pl. LVI, 6.
1894. Pinnatopora trilineata Keyes, Missouri Geol. Surv., V, p. 31.
1900. Pinnatopora trilineata Nickles and Bassler, Bull. 173, U. S. G. S., p. 357.
1901. Pinnatopora trilineata, Rogers, Kans. Univ. Quar., No. 4, pp. 245, 247, etc.
1903. Pinnatopora trilineata (Meek), Barber, Nebraska Geol. Surv., I, p. 127.

Zoarium a pinnate frond. Midrib cylindrical, finely striated on the reverse, 0.5 mm. wide, giving off from each side at angles of 65-70 degrees, twelve pinnae in 1 cm. Pinnae subalternately placed, 0.26 mm. wide, 1 to 2 mm. long and about the width of the midrib apart. Longitudinal striae show on the reverse of the midrib and pinnae. "Obverse face of midribs subangular with three fine straight lines along the center, the median one slightly the strongest. Pinnae similarily marked but on a smaller scale." Zooecia in two ranges on the midrib and pinnae. "Apertures circular, 0.09 mm. across, two diameters apart, seventeen in 5 mm." Apertures slightly smaller on the pinnae; when perfectly preserved, they are surrounded by thin elevated peristomes. One aperture occurs opposite the

upper part of the base of each pinna and two occur in the space between on each side of the midrib.

The three mesial lines constitute the principal external peculiar character of the species; the size of the midrib as well as the number of pinnae in a given space are also important. My observations agree with those of E. O. Ulrich, in that there are twelve pinnae on each side of the midrib in 1 cm., instead of eight or nine as recorded by Meek. One specimen has thirteen in 1 cm. A fragment collected at Plattsmouth shows the trilineate appearance quite well.

Occurrence—Coal Measures: Nebraska City, Nebraska, (Meek); Sangamon county, Illinois; Kansas City, Missouri; Plattsmouth, La Platte, Nebraska City, and Roca, Nebraska.

Pinnatopora pyriformipora *Rogers*

Pl. XVII, Figs. 9-10.

1900. Pinnatopora pyriformipora Rogers, Kans. Univ. Quar., IX, No. 1, p. 9, pl. 11, 6, 6a.

1903. Pinnatopora pyriformipora Rogers, Barbour, Nebraska Geol. Surv., I, p. 127.

Zoarium a small pinnate frond, usually not more than 3 cm. high. Midrib fairly straight, about 0.5 mm. wide, rounded on the reverse but not as cylindrical as P. trilineata, showing small tubercles placed about even with the base of each alternating pinna; obverse face of midrib and branches with a fairly distinct mesial carina carrying nodes placed at intervals of about 0.4 mm. with twelve in 5 mm.; obverse face of the pinnae with small carina and nodes at distances of 0.27 mm. Lateral branches, averaging 0.4 mm. wide, are given off from the midrib at distant intervals, and also become pinnate. Pinnae a little more than the width of the midrib apart, given off from the midrib and branches at angles 75 to 80 degrees, .25-.3mm. wide, 1 to 2 mm. long, with twelve on each side in 1 cm.

Zooecia in two alternating ranges on the midrib, branches and pinnae. Apertures circular, small, 0.07 to 0.08 mm. in diameter, two to three times their own diameter apart, placed

one opposite the base of each pinna on each side of the carina with two in the space between, eight occuring in 5 mm. Rogers' specimens have pyriform apertures, smaller node and a more prominent carina; the reverse face was not observed by him. If specimens found here prove specifically distinct, the name P. spinulosa should be used as that is the name under which the writer had placed them before Rogers defined his species.

Nebraska specimens resemble P. trilineata Meek in general zoarial measurements, but have a very different reverse face with small tubercules. The obverse face does not show a triliniate carina, but has spines on a carina. Nodes though absent in Meek's species, are so prominent in old growths of Nebraska specimens, supposed to be P. pyriformipora, that the two species are easily distinguished by the unaided eye. Specimens in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Argentine, Kansas; Plattsmouth, and Roca, Nebraska. Quite common in the first Warner quarry one mile north of Roca.

Pinnatopora youngi *Ulrich*

PL. XVIII, FIG. 1.

1888. Pinnatopora youngi Ulrich, Bull. Denison Univ., IV, p. 78, pl. XIV, 6, 6a.

1890. Pinnatopora youngi Ulrich, Geol. Surv. Ill., VIII, p. 615, pl. LXVI, 3.

1894. Pinnatopora youngi Ulrich, Keyes, Missouri Geol. Surv., V, p. 31.

1900. Pinnatopora youngi Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 357.

1903. Pinnatopora youngi Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

The writer supposed the specimens found here represented a new species and sent some of them to Mr. Ulrich for verification, who pronounced them identical with specimens which he had collected from a number of localities and to which he has given the manuscript name P. youngi var. carbonaria.

This variety differs from typical specimens of the species in having a slightly smaller midrib, and thirteen instead of eleven pinnae, on each side, in a space of 1 cm. The apertures are smaller and are not so far apart, with thirteen, instead of eleven in each series, in 5 mm. The carina and nodes appear less well developed. Specimens in the collection of E. O. Ulrich, Newport, Kentucky, and in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska. Found in the Coal Measures at Plattsmouth, Nebraska. Typical specimens of the species have been collected by E. O. Ulrich as follows: Waverly: Richfield, and Lodi, Ohio; Keokuk: Keokuk, Iowa; King's Mountain, Kentucky.

Septopora *Prout*

1859. Septopora Prout, Trans. St. Louis Acad. Sci., I, p. 448. For bibliography, see Nickles and Bassler, Bull. 173, U. S. G. S., p. 404, 1900.

"Zoarium a fenestrate, flabellate or leaf-like expansion; primary branches numerous, increasing by bifurcation or interpolation; the lateral branches unite with those from the adjacent primary branches; apertures in two rows on primary and lateral branches; reverse usually with fine striae and scattered dimorphic pores." Fenestrated species are distinguished from Polypora and Fenestella by the presence of apertures on the dissepiments.

Genotype: Septopora cestriensis Prout. Range, Mississippian—Coal Measures. The genus is represented in the state by a large number of specimens, most of which should be referred to S. biserialis (Swallow) which species includes practically all fenestrated forms. The following species and varieties have been collected in the state: S. decipiens Ulrich, S. multipora (Rogers), S. cestriensis Prout, S. biserialis (Swallow), S. biserialis-nervata Ulrich, S. pinnata Ulrich, and S. robusta Ulrich.

Septopora decipiens *Ulrich*

PL. XVIII, FIG. 2.

1890. Septopora decipiens Ulrich, Geol. Surv. Ill., VIII, p. 630, pl. LXVI, 9.
1900. Septopora decipiens Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 405.
1903. Septapora decipiens Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

"Zoarium a narrow pinnate stripe, dividing dichotomously at distant intervals, with often a fenestration for a short distance above the bifurcation." "Usually the pinnae are short, subcarinate, taper rapidly, with twelve or thirteen on each side in 1 cm. Midrib increasing gradually in width from 0.5 to 0.9 or 1 mm. between the bifurcations; on the obverse with a well defined rounded carina, carrying faint nodes 1 mm. apart. Zooecia in two ranges except often just beneath a bifurcation where three rows may prevail for a short distance. Apertures rather large, suboval, 0.15 mm. long, as much or less apart, number between pinna seventeen in 5 mm. Peristome very faint. Accessory pores small, about 0.05 mm. in diameter, distributed at irregular intervals among the zooecia apertures. Reverse of midrib rather broadly rounded, very finely striated, with a small number of accessory pores." (Ulrich)

As yet only a few undoubted specimens of this species have been found in Nebraska. The midrib is 1.1 mm. wide below a bifurcation; the apertures are slightly farther apart than typical, with sixteen instead of seventeen occuring in 5 mm. In other respects the best specimen secured agrees with the above description.

Occurrence—Chester Group: Sloan's Valley, Kentucky; Coal Measures: Plattsmouth, and Ashland (?), Nebraska. So far as the writer knows, this is the first reported occurrence of the species in the Coal Measures.

Septopora multipora (*Rogers*)

PL. XVIII, FIGS. 3, 4.

1900. Pinnatopora multipora Rogers, Kansas Univ. Quar., IX, No. 1, pl. III, 2, 2a.
1901. Pinnatopora multipora Rogers, Kansas Univ. Quar., IX, No. 4, p. 247.
1903. Septapora multipora (Rogers), Barbour, Nebr. Geol. Surv., I, p. 128.

"Zoarium a rather large pinnate frond. Midrib straight, 0.5 mm. wide, giving off on each side four branches in 5 mm. Pinnae long and slender, about 0.3 mm. wide, given off subalternately at an angle of about 75 degrees. Zooecia in two alternating rows. Apertures small, subcircular, about their own diameter apart, seventeen in 5 mm. One aperture occurs at the small angle of the pinnae with the midrib, and five in the space between. Reverse face covered with fine longitudinal striae and circular pores, with moderately well defined peristomes. Obverse face not seen." (Rogers)

Nebraska specimens, though somewhat more robust, agree in the main with the above description. The midrib is 0.5 to 0.7 mm. wide; the pinnae averaging 0.30 mm. wide, unite by dissepiments proving that the specimens belong to the genus Septopora and not to Pinnatopora as given by Rogers. The reverse pores are also indicative of the generic position. The obverse face shows a rounded carina, 0.15 mm. wide, with small nodes placed at distances of 0.35 mm. Zooecia subalternately placed in two not very regular ranges. Apertures subcircular, one and one-half to twice their own diameter apart, seventeen to nineteen in 5 mm., with about five in each range in the space between the junction of the pinnae and midrib. Two ranges occur on the pinnae. This species is closely related to Septopora decipiens Ulrich, but has eight instead of twelve to thirteen lateral branches or pinnae on each side of the midrib in 1 cm.

If Rogers' specimens differ in zoarial characters (as they may) so that they should be placed with the genus Pinnatopora, the

Nebraska specimens will, in that event, be a distinct species of Septopora. Specimens in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska. It may be that Meek measured specimens of this species instead of P. trilineata, thereby causing him to make the error in respect to the number of pinnae in 1 cm. (See Geol. Surv., Ill., VIII, pp. 620, 621).

Occurrence—Coal Measures: Eudora, Douglas county, Kansas; Plattsmouth, Southbend, Roca, and Louisville, Nebraska.

Septopora cestriensis *Prout*

PL. XIX, FIG. 2.

1859. Septopora cestriensis Prout, Trans. St. Louis Acad. Sci., I, p. 448, pl. XVIII, 2-2b.
1890. Septopora cestriensis Ulrich, Geol. Surv., Ill., VIII, p. 628, pl. LXIV, 1, 1b.
1894. Septopora cestriensis, Keyes, Missouri Geol. Surv., V, p. 32.
1897. Septopora cestriensis, Simpson, Fourteenth Ann. Rep. St. Geol. New York, for yr. 1894, p. 515, fig 65.
1900. Septopora cestriensis, Nickles and Bassler, Bull. 173, U. S. G. S., p. 405.
1903. Septopora cestriensis Prout, Barbour, Nebr. Geol. Surv., I, p. 127.

"Zoarium a rather delicate, but compactly woven flabellate expansion," of medium size. Branches narrowly rounded on the reverse, not very straight, striated when young, increase in number by bifurcation, average width 0.55 mm., 0.6 to 0.8 mm. before, and 0.3 to 0.4 mm. immediately after bifurcation, with twelve in 1 cm. Accessory pores circular, 0.07 to 0.09 mm. if diameter, with usually one or two placed near each end on each dissepiment. The obverse face is subangular, with a small carina carrying nodes placed at distances of about 1 mm.

Dissepiments pass nearly straight between branches, with a considerable terminal expansion; on the reverse, they are quickly rounded, on a level with or slightly depressed below the branches, and striated if young.

Fenestrules small, subcircular near the base of the zoarium, more subquadrate in the periphery, with eleven in 1 cm.

"Zooecia in two ranges, but a third is occasionally interpolated just before a bifurcation. Apertures circular, 0.14 mm. in diameter, about two-thirds of their own diameter apart, twenty-two to twenty-three in 5 mm." Commonly four apertures are placed on each dissepiment, the number varying from two to five. Accessory pores are generally found on the dissepiments and a few may occur among the zooecia.

"The distinguishing features of this species are the compact appearance of the network, the small rounded fenestrules, large number of branches in a given space, the short dissepiments and few zooecia on them, and the comparatively large size of the accessory pores. These differences apply particularly to its nearest relative and associate, S. subquadrans." The species is quite readily distinguished from S. biserialis (Swallow) and closely related forms by the manner in which branches increase in number. The increase is by bifurcation and not by interpolation or lateral division, as in closely related forms. This is the first published report of the occurrence of the species in the Coal Measures.

Occurrence--Chester Group: Chester, Illinois; Sloan's Valley, and several localities in Western Kentucky. (Ulrich).

Coal Measures: Southbend and Plattsmouth, Nebraska.

Septopora biserialis (*Swallow*)

PL. XVIII, FIG. 5.

1858. Synocladia virgulacea Phillips (?), Swallow, Trans. St. Louis Acad. Sci., I, p. 179.

1858. Synocladia biserialis Swallow, Trans. St. Louis Acad. Sci., I, p. 179.

1860. Synocladia biserialis, Meek and Hayden, Proc. Acad. Nat. Sci., Phil., p. 24.

1866. Synocladia virgulacea (not of Phillips), Geinitz, Carb. und Dyas in Nebraska, p. 70, pl. V, 14.

1870. Synocladia virgulacea var. biserialis, Meek and Worthen, Geol. Surv., Ill., V, pl. XXIV, 15a-c.

1872. Synocladia biserialis, Meek, Pal. Eastern Nebr., p. 156, pl. VII, 5a-5e.
1874. Synocladia biserialis, Meek, Amer. Jour. Sci. Arts., Ser. 3, VII, p. 486.
1877. Synocladia biserialis, White, Wheeler's U. S. G. S., IV, p. 107, pl. VII, 3a-c.
1884. Synocladia biserialis, White, Thirteenth Ann. Rep. Indiana, Geol. Nat. Hist., part 2, p. 138, pl. XXV, 11-13.
1887. Septopora biserialis, Foerste, Bull. Sci. Lab. Denison Univ., 11, p. 87; ibid., III, 1888, pl. VII, 16a-c.
1888. Synocladia biserialis, Keyes, Proc. Acad. Nat. Sci. Phila., p. 225.
1890. Septopora biserialis, Ulrich, Geol. Surv. Ill., VIII, p. 631, pl. LVI, 11.
1894. Septopora biserialis, Keyes, Missouri Geol. Surv., V, p. 32, pl. XXXIV, 1a-d.
1896. Septopora biserialis, Smith, Proc. Amer. Phil. Soc., XXXV, p. 237.
1898. Septopora biserialis, Darton. Irrigation Paper. No. 12, U. S. G. S., p. 16.
1900. Septopora biserialis, Nickles and Bassler, Bull. 173, U. S. G. S., p. 405.
1901. Septopora biserialis, Rogers, Kans. Univ. Quar., IX, No. 4, pp. 239, 240, etc.
1903. Septopora biserialis (Swallow) Barbour, Nebr. Geol. Surv., I, p. 127.

"Zoarium large, irregular, infundibuliform, strongly folded and often overlapping in the upper portions." Branches nearly parallel (except near the base), increase in number by interpolation or by lateral division, evenly rounded, smooth or striated, with few accessory pores on the reverse; obversely, they are convex except for a small mesial carina which carries nodes 0.5 by 0.8 mm. apart; nodes long and prominent on old specimens.

"Branching averaging 0.5 mm. wide, but varying from 0.3 or 0.4 to 0.7 or 0.8 mm. with nearly uniformly ten in 1 cm." Some specimens show eleven or twelve in 1 cm. Dissepiments usually arched, sometimes straight, two-thirds as wide as

the branches, depressed and often striated on the reverse, at times faintly carinated on the obverse, with accessory pores scattered among the zooecial apertures. "Fenestrules usually transversely oblong, often irregularly quadrangular or somewhat crescentric, wider than the branches, about thirteen in 1 cm." They vary much with the condition or age of growth.

Zooecia in two ranges on the branches and dissepiments; apertures subcircular, with thin peristomes, 0.12 to 0.14 mm. in diameter, about two-thirds their own diameter apart, twenty to twenty-one in 5 mm.; three to eight apertures occur on each dissepiment.

The species is distinguished from S. subquadrans Ulrich, principally by the method by which the number of branches is increased, namely interpolation and lateral division instead of bifurcation, as in the latter. The species is closely related to S. robusta, but has fewer accessary pores on the reverse faces and does not have three ranges of zooecia on the dissepiments.

Occurrence—Coal Measures: "Various localities in Kansas, Nebraska, Missouri, Indian Territory, Iowa, Illinois, Ohio, and Kentucky." This is one of the most common fossils found in Nebraska, occurring in many of the Coal Measure exposures, as at Plattsmouth, LaPlatte, Cedarcreek, Richfield, Southbend, Louisville, Ashland, Falls City, Dawson, Tecumseh, Tablerock, Bennett, Rulo, Peru, Nebraska City, Rockbluff, Nehawka, Weeping Water, and Roca.

Septopora biserialis-nervata *Ulrich*

PL. XIX, FIG. 1, AND FRONTISPIECE.

1890. Septopora biserialis var. nervata Ulrich, Geol. Surv. Ill., VIII, p. 632, pl. LXIV, 6.
1900. Septopora biserialis-nervata Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 405.
1903. Septopora biserialis-nervata Ulrich, Barbour, Nebr. Geol. Surv., I, p. 127.

This variety is well represented in the state, especially in the shales at Roca, where specimens, usually well preserved, are easily collected; one of the largest specimens is 8 cm. high by

6.5 cm. wide. The zoarium is fan-shaped, consisting of primary and secondary branches; the former are given off radially from the base and in turn give rise, at acute angles from their sides, to secondary branches which gradually increase in size and in turn become pinnated. Nebraska specimens have an average of nine branches and ten fenestrules in 1 cm.

"They differ from the typical form of the species in having primary and secondary branches, the former being much stronger than the latter and arranged in a radial manner around the base."

Occurrence—Chester Group: Kentucky; Coal Measures: Illinois; near Red Oak, Iowa; Roca, Plattsmouth, Southbend, Louisville, La Platte, Bennett, and Tablerock, Nebraska.

Septopora pinnata *Ulrich*

PL. XX, FIGS. 1, 2.

1890. Septopora pinnata Ulrich, Geol. Surv., Ill., VIII, p. 633, pl. LXIV, 7, pl. LXV, 1, 1a.

1900. Septopora interoporata Rogers, Kans. Univ. Quar., IX, No. 1, p. 11, pl. III, 3, 3a.

1900. Septopora pinnata Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 406.

1903. Septopora pinnata Ulrich, Barbour, Nebr. Geol. Surv., I, p. 128.

Zoarium a pinnate frond consisting of one or more midribs and lateral branches; midribs rounded on the reverse, but carinate on the obverse, where each bears a row of small nodes 0.35 mm. apart; branches 0.5 to 0.7 mm. wide. Lateral branches given off subalternately from the midrib at less acute angles than in S. biserialis-nervata Ulrich; they are also carinated. "Eight branchlets averaging 0.3 mm. wide are given off from each side of the midribs in 1 cm." Dissepiments relatively large, arched or straight. Fenestrules usually about as wide as the branches with eight to ten in 5 mm. Zooecial apertures subcircular, about their own diameter apart, with nineteen or twenty in 5 mm. and two to nine on each dissepiment.

Small pores are often found between the zooecial apertures; these also occur in other species of the genus.

This so-called species is not very different from basal portions of S. biserialis (Swallow), and it is doubted, therefore, whether it represents a logical species distinct from S. biserialis. S. interporata Rogers is without much doubt a synonym.

Occurrence—Coal Measures: Jasper county, Illinois; Argentina, Kansas; Roca, Louisville, Southbend, Peru, Bennett, and Plattsmouth, Nebraska.

Septopora robusta *Ulrich*

PL. XVIII, FIGS. 6, 7.

1890. Septopora robusta Ulrich, Geol. Surv., Ill., VIII, p. 633, pl. LVI, 9-9c, pl. LXIV, 3, 3a.

1900. Septopora robusta Ulrich, Nickles and Bassler, Bull. 173, U. S. G. S., p. 406.

1903. Septopora robusta Ulrich, Barbour, Nebr. Geol. Surv., I, p. 128.

Zoarium a flabellate expansion resembling S. biserialis (Swallow) in general appearance, but more robust. Branches rounded and striated on the reverse, at times quite convex, average 0.7 to 0.8 mm. wide, with five to eight, usually five or six in 1 cm. The obverse face has a keel with prominent nodes placed 0.4 to 0.7 mm. apart; aged specimens show very large nodes. Dissepiments arched or direct, depressed, and narrowly rounded on the reverse. Fenestrules nearly obliterated in very old growth, average wider than long, also wider than the branches, with seven or eight in 1 cm. longitudinally.

"The zooecia form two ranges on the branches, with twenty-two or twenty-three in 5 mm. and three irregular rows on the dissepiments. The apertures are comparatively large, being 0.14 mm. in diameter and separated by a little more than half their diameter." Seven to twenty apertures or more occur on the obverse face of each dissepiment; diameter with peristome 0.21 mm.; one specimen has four irregular rows of zooecia on each dissepiment. A few accessory pores occur among the zooecial

apertures. Numerous accessory pores 0.08 to 0.13 mm. in diameter occur scattered over the reverse face of branches.

This species is distinguished by its robust appearance, the presence of three ranges of zooecia on each dissepiment, and by the large number of accessory pores on the reverse face. Separated branches may be confused with S. multipora (Rogers).

Occurrence—Coal Measures: Fayette county, Illinois; Bennett, Tablerock, Louisville, La Platte, and Dawson, Nebraska. It is very common at Bennett.

Rhabdomesontidae *Vine*

"Zoarium ramose or simple, not articulated, sometimes with an axial tube, but generally solid, in which case the axial region is occupied by thin-walled primitive tubes, with or without diaphragms; hemisepta usually present, but never conspicuous; apertures circular or oval, usually in linear series between longitudinal elevated ridges, or in diagonally intersecting series; vestibule a rhombic or hexagonal sloping area; mesopores generally absent." Represented in the Coal Measures of America by three genera—Rhombopora Meek, Streblotrypa Ulrich, and Rhabdomeson Young and Young, the first two of which are found in Nebraska. Rogers has recently collected representatives of the last named genus in Kansas and Missouri.

Rhombopora *Meek*

1872. Rhombopora Meek, Pal. Eastern Nebraska, p. 141. For bibliography, see Bull 173, U. S. G. S., p. 393, 1900.

"Zoarium slender, ramose, solid; zooecia thick-walled in vestibular region; apertures in longitudinal or diagonally intersecting series; acanthopores present, sometimes of two kinds, large and small." The name is based on the rhombic vestibules. Diaphragms may be present in small numbers. This genus is closely related to Stenopora and Batostomella. A few specimens collected here are very puzzling and can not be correctly placed until some one well acquainted with these genera,

and with plenty of specimens for study, establishes the limits of each genus. The common species is Rhombopora lepidodendroides Meek. Specimens doubtfully referred to R. crassa Ulrich, and R. persimilis Ulrich have been collected.

Genotype: Rhombopora lepidodendroides Meek. Range, Silurian-Permian.

Rhombopora lepidodendroides *Meek*

PL. VI, Figs. 2-4; Pl. VII, FIGS. 1-12.

1866. Stenopora columnaris, Geinitz (not of Schlotheim, 1813, in part) Carb. und Dyas in Nebraska, p. 66.
1872. Rhombopora lepidodendroides Meek, Pal. Eastern Nebr., p. 141, pl. VII, 2a-f.
1877. Rhombopora lepidodendroides (?), White, Wheeler's U. S. G. S., IV, Pal., p. 99, pl. VI, 5a-d.
1884. Rhombopora lepidodendroidea, Ulrich, Jour. Cincinnati Soc. Nat. Hist., VII, p. 27, pl. I, 1-1b.
1887. Rhombopora lepidodendroidea, Foerste, Bull. Sci. Lab., Denison Univ., II, p. 73, pl. VII, 3a, b.
1888. Rhombopora lepidodendroides, Keyes, Proc. Acad. Nat. Sci., Philadelphia, p. 225.
1894. Rhombopora lepidodendroides, Keyes, Missouri Geol. Surv., V, p. 35, pl. XXXIII, 4a, b.
1896. Rhombopora lepidodendroides, Smith, Proc. Amer. Phil. Soc., XXXV, p. 237.
1899. Rhombopora lepidodendroides (?) Meek, Knight, Jour. Geol., VII, p. 366.
1900. Rhombopora lepidodendroides Meek, Nickles & Bassler, Bull. 173, U. S. G. S., p. 395.
1901. Rhombopora lepidodendroides, Rogers, Kans. Univ. Quar., IX, No. 4, pp. 240, 241, 245.
1903. Rhombopora lepidodendroides Meek, Condra, Amer. Geol., XXXI, No. 1, pp. 22-24, pl. II, 1-10.
1903. Rhombopora lepidodendroides Meek, Barbour, Nebr. Geol. Surv., 1, p. 127.

"Among a very large number of Coal Measure fossils found in

Nebraska, some of which have been of service in determining stratigraphy, the following seem to be the most common and widely distributed: Fusulina secalica, Seminula argentea, Chonetes granulifer, Spirifer cameratus, and Rhombopora lepidodendroides. The last named species has a wide range both vertical and horizontal; it is more or less plentifully found in nearly all Coal Measures exposures of the state, and in the Permian at Blue Springs and Wymore.

The first specimens were collected from outcrops along the Missouri river by Professor Marcou. They were identified by Professor Geinitz of Dresden, in 1866, as Stenopora columnaris (Schlotheim 1813, in part). According to Meek, who published the species in 1872, the specimens observed by Geinitz were R. lepidodendroides Meek incrusted by Fistulipora nodulifera Meek. The writer has found several specimens which were quite concealed by Fistulipora nodulifera Meek. It is very evident, therefore, that Professor Geinitz may have erroneously identified two new species, one covering the other, as a single described species."

Meek's diagnosis is based on the young growth, and, as a result, the species is often imperfectly known by that condition alone. The writer has collected and placed in the Morrill Collection in the museum of the University of Nebraska not less than fifty pounds, representing several thousand nice clean specimens. They fall under the following ramose growths: 1, young condition; 2, old condition without monticules; 3, old condition with monticules. To these ramose growths may be added, the incrusting form, which is rarely found. From superficial characters, the casual observer would try to separate the specimens into as many species as there are conditions of growth.

Zoaria ramose, rarely incrusting, cylindrical or slightly compressed, straight to irregular in extent between bifurcations, in young and old conditions; surface smooth or montiferous; bifurcations at irregular intervals, equal or unequal in size, angle variable, usually 60 to 80 degrees. Young specimens, pl. VI, figs. 2, 3; pl. VII, figs. 1-5, slender, cylindrical, small, average diameter less than 2 mm., surface papillose, due to projecting acanthopores. Old conditions, pl. VII, figs. 7-12, larger, more

irregular, with or without monticules, size variable, diameter 3 to 8 mm., average 4 or 5 mm.; monticules of montiferous specimens differ in size and arrangement as shown by pl. VII, fig. 10.

"Zooecia curve gradually from central to cortical portions of zoarium, through which, in old growths, they continue in nearly straight lines to the apertures; walls in central or immature region thin, in cortical or mature portion thick, with acanthopores as a prominent feature; acanthopores or tubuli, as they are sometimes called, between zooecial walls, of two sizes, large and small, project from the surface when well preserved. Zooecial cavities or cells polygonal in the immature region, circular in section and usually smaller in the mature portion. Tabulae wanting in most cells, but frequently found in old growths. Apertures subcircular in form, arranged (in young growth) in vertical and diagonally intersecting series which open into rhombic or subelliptical vestibules; vestibules in very young specimens subelliptical. The intersecting series and vestibules are not plainly shown in old growths." The removal of the vestibules is sometimes due to abrasion.

"These brief notes may show that the so-called rhombic vestibule has been over-estimated as a character. Probably the incrusting form has been described as a species under Stenopora. The systematic position of the species is held in dispute. Meek placed it under the polypi."

Occurrence—Coal Measures: "A rather common species at various localities in Nebraska; Kansas, Missouri, Iowa, Illinois, and Ohio." Found at Bennett, Roca, Ashland, Southbend, Louisville, Richfield, Cedarcreek, La Platte, Plattsmouth, Wyoming, Nebraska City, Tecumseh, Tablerock, Humboldt, Dawson, Salem, Falls City, Weeping Water, Nehawka, Rockbluff, and other localities in Nebraska. The young growths occur in large numbers at Tablerock, while specimens in the old conditions of growth are even more abundantly found just above a thick bed of flinty limestone outcropping along the Platte river from Louisville to Southbend. Permian: Some years ago Professor Knight collected specimens at Blue Springs, and Wymore and referred them with question to this species. Since that time

the writer has identified the species in the Florence flint at those places. Professor Prosser has collected and identified specimens from the Permian of Kansas. The above description by the writer, but slightly modified, was recently published in the American Geologist.

Streblotrypa *Ulrich*

1890. Streblotrypa Ulrich, Geol. Surv. Illinois, VIII, pp. 403, 665.
1897. Streblotrypa, Simpson, Fourteenth Ann. Rep. St. Geol. New York, for yr. 1894, p. 551.
1899. Streblotrypa, Grabau, Bull., Buffalo, Soc. Nat. Sci., VI, p. 167.
1900. Streblotrypa, Nickles and Bassler, Bull. 173, U. S. G. S., pp. 44, 420.

Zoarium ramose, slender, solid; zooecia long, tubular, diverging from an imaginary central axis; inferior hemiseptum best developed, and situated well down in the lumen of the zooecium; apertures elliptical, peristomed, usually in longitudinal series; small pits, one to twelve or more in number, and arranged in two or more rows when numerous, occur between the apertures; small acanthopores may be present. Specimens of Rhombopora lepidodendroides in which the acanthopores have weathered out, forming apparent mesopores, are very deceptive and might, by a casual examination, be wrongly identified as members of this genus. A few specimens in that condition were observed.

Genotype: Streblotrypa nicklesi Ulrich. Range, Devonian-Permian.

Only two species have been reported from the Coal Measures of America, one of which, S. prisca, occurs in Nebraska.

Rogers recently collected the same in the Permian, at Grand Summit, Kansas.

Streblotrypa prisca (*Gabb and Horn*)

PL. XX, FIGS. 3-8.

1862. Cavea prisca (Gabb and Horn), Jour. Acad. Nat. Sci., Phila., Ser. 2, V, p. 175, pl. XXI, 67.
1900. Streblotrypa ulrichi, Rogers, Kansas Univ. Quar., IX, No. 1, Ser. A, p. 3, pl. 1, 3, 3a.
1900. Streblotrypa prisca, Nickles and Bassler, Bull. 173, U. S. G. S., p. 422.
1901. Streblotrypa prisca, Rogers, Kans. Univ. Quar., IX, No. 4, p. 252.
1903. Streblotrypa prisca (Gabb-Horn), Barbour, Nebr. Geol. Surv., I, p. 128.

Zoarium a long, cylindrical branch with lateral and dichotomously formed divisions; branches generally straight, 0.5 to 1 mm. in diameter, circular in cross section, dividing at distant intervals; lateral divisions thrown off at nearly right angles from the main stem or its divisions; surface modified by slightly wavy longitudinal ridges between which occur shallow depressions into which the apertures and mesopores open; zooecial tubes long, nearly equal in width throughout, curve slowly to the surface, walls thin, with inferior hemiseptum; superior hemiseptum not observed by the writer. Apertures oval, surrounded by thin peristomes, arranged in alternating longitudinal rows which are separated by straight or undulating ridges, quite large, longer axis vertical, 0.8 by 0.14 mm. across, with eleven occurring in 5 mm. longitudinally, and three in 0.77 mm. diagonally. Small pits or mesopores, usually in two rows, placed at regular intervals, generally with six in each cellule or depression.

"This species resembles S. nicklesi, Ulrich, but has much larger cells." Without doubt Rogers' S. ulrichi is a synonym. The species is quite plentifully represented in an impure limestone in the Warner quarries, one mile north of Roca, Nebraska.

Occurrence—Coal Measures: Fort Belknap, Texas; Lawrence, Scranton, Topeka, Cottonwood Falls, and ten miles north of Manhattan, Kansas; Ashland, Plattsmouth, Falls City, Bennett, and Roca, Nebraska. "Permian at Grand Summit, Kansas." (Rogers).

Cystodictyonidae *Ulrich*

"Zoarium consisting of two or three layers of cells grown together back to back, forming branching, fenestruled, or entire leaf-like expansions or triangular branches; zooecia semicordate or obovateacuminate in outline, arranged longitudinally; orifices subcircular, vestibule elongated; apertures with peristome and more or less well developed lunarium; interzooecial spaces occupied by vesicular tissue, often filled with a calcareous deposit near the surface."

The family is represented in the Coal Measures of Nebraska by a single genus, Cystodictya Ulrich.

Cystodictya *Ulrich*

1882. Cystodictya Ulrich, Jour. Cincinnati Soc. Nat. Hist., V, pp. 152, 170. See Bull. 173, U. S. G. S., p. 220, 1900, for bibliography.

"Zoarium ramose, branches sharply elliptical in cross section, with subparallel, nonporiferous margins; apertures subelliptical, in linear series between longitudinal ridges, which may not always be present, lunarium on the side of the aperture nearest the margin of the branch; interspaces finely striated, granulose or smooth; pits and cells show only in a worn condition."

Genotype: Cystodictya ocellata Ulrich. Range, Devonian-Coal Measures. Represented in Nebraska by three species, C. anisopora Condra, C. inequamarginata Rogers, and C. lophodes Condra. All specimens found here occur in the upper beds of the Coal Measures.

Cystodictya anisopora *Condra*

PL. XXI, FIGS. 1-5.

1902. Cystodictya anisopora Condra, Amer. Geol., XXX, No. 6, pp. 355, 356, pl. XXV, 1-5.

1903. Cystodictya anisopora Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a bifurcating and laterally dividing branch, 0.8 mm.

or more thick, 1 to 1.25 mm. or more wide between the bifurcations, 1.5 mm. wide just below a bifurcation or division, subelliptical in section; one margin usually appears sharper than the other, resembling, to a degree, C. inequamarginata Rogers. Bifurcations not numerous, at wide angles.

Zooecial apertures in four, five or six, usually five linear series on each face of the zoarium; the number of rows is yet larger just below a bifurcation. Apertures subcircular to elliptical in form, elevated, forming a small lip on the side of the wide margin when perfect, vary in size in the different series, large to small, about 0.14 mm. wide by 0.18 to .2 mm. long in the row nearest the wide margin, smallest in the row nearest the narrow margin, two or three times their own diameter apart longitudinally (more in the fifth range), closer laterally. The first range has six and one-half or seven apertures in 5 mm., the third eight, and the fifth nine and one-half; no longitudinal ridges were observed; apertures of well preserved specimens usually located on prominent transverse ridges, except the less prominent apertures of the fifth range, which are located near the narrow margin. The apertures of this range occur between the small ends of the transverse ridges and alternate with the apertures of the fourth range. The transverse ridges are highest and broadest near the wide margin and decrease in width and elevation towards the narrow margin.

The zooecia of the two faces of the zoarium are separated by a definite mesotheca, lie close together against the latter, and are incompletely separated from each other by vesicular tissue. The main body of each zoarium is vertical, from which a vestibule or neck curves quickly to the surface.

This species is related to C. inequamarginata Rogers, but has greater range in the size of apertures. The zoaria are more robust, and show, when perfectly preserved, transverse ridges. There are four or five and sometimes six, instead of three or four longitudinal series of apertures; also, about six and one-half to seven instead of ten large apertures occur in 5 mm. in the range nearest the broad margin. The name is based on

the unequal apertures. Type specimens Nos. 4-18-2-99 and 17-5-02 in the Morrill Collection in the museum of the University of Nebraska, Lincoln, Nebraska.

Occurrence—Coal Measures: Roca, Ashland, and Louisville, Nebraska.

Cystodictya inequamarginata *Rogers*

PL. XXI, FIG. 10.

1900. Cystodictya inequimarginata Rogers, Kans. Univ. Quar., IX, No. 1, p. 2, pl. I, 2-2b.

1903. Cystodictya inequimarginata Rogers (?), Barbour, Nebr. Geol. Surv., I, p. 127.

The first specimens of this species were collected at Roca, 1897. They agree in the main with Rogers' description, which is as follows:

"Zoarium a long stipe, dichotomously dividing at frequent intervals. Branches acuminate-ovate or subcircular in cross section, about 1 mm. wide and 0.75 mm. thick. Nonporiferous margin narrow and sharp on one side; rather wide and rounded on the other. Zooecial apertures much elevated in unworn specimens, small, subcircular, separated longitudinally by about twice their own diameter; arranged in three or four linear series. In a space of 3 mm. six apertures occur in the row nearest the wider margin, while eight occur in the same distance in the row nearest the narrow margin. Apertures also quite regularly arranged in diagonal series, about four in 1 mm. Between the cell ranges obscure longitudinal ridges often occur."

Occurrence—Coal Measures: Lawrence, Kansas; Kansas City, Missouri (Rogers); Roca, Nebraska.

Cystodictya lophodes *Condra*

PL. XXI, FIGS. 6-9.

1902. Cystodictya lophodes Condra, Amer. Geol., XXX, No. 6, p. 352, pl. XXV, 6, 7.

1903. Cystodictya lophodes Condra, Barbour, Nebr. Geol. Surv., I, p. 127.

Zoarium a bifurcating stipe, subcircular or slightly elliptical

in section, 1. to 1.5 mm. wide between bifurcations, about 2. mm. at a bifurcation; angle of bifurcation wide. Nonporiferous margins narrow, equal or about equal in width. Zooecial apertures in linear series between longitudinal ridges. Ridges 0.2 mm. apart. Four or five, rarely three subalternate ranges of apertures occupy each face of the zoarium. "The number is increased to six or seven below each bifurcation. Apertures subcircular to elliptical, rather large, 0.12 to 0.14 mm. wide by 0.18 mm. or more long, differ little in size, about twice their own diameter apart longitudinally, about the same distance apart in each range, with eight in 5 mm. in each range; they open into trough-like depressions between the longitudinal ridges. Peristome complete or incomplete, usually showing a small lip. One well preserved specimen shows apertures less than two diameters apart, averaging 0.2 long and 0.16 mm. wide; the length with the peristome is 0.3 mm.; the longitudinal ridges do not show plainly at the bifurcations. Vesicular tissue composed of small irregular vesicles is closely packed about the zooecia.

Distinguished from C. anisopora by the more equal apertures and margins and the absence of transverse ridges. In perfect specimens the apertures open between longitudinal ridges instead of being elevated on the oblique ridges as they usually are in that species. It is not known just how closely this species is allied to C. divisa Rogers which was briefly described from hemibranchs and sections, the poriferous faces not showing. Specimens of this species do not divide into hemibranchs. Type specimen No. 5-7-4-00 in the Morrill Collection in the museum of the University of Nebraska.

Occurrence—Coal Measures: Roca, Nebraska.

TABLES FOR IDENTIFICATION OF NEBRASKA BRYOZOA

Key to Genera:

1. Zoarium fenestrated; branches usually small, with carina; zooecia in two ranges, on branches only. **Fenestella.** See Table I.

2. Zoarium fenestrated; zooecia in two to eight ranges, on branches only. **Polypora.** Table II.

3. Zoarium pinnate, bifurcate or palmate, without dissepiments, otherwise much like Polypora. **Thamniscus.** Table II.

4. Zoarium usually fenestrated; zooecia on branches and dissepiments. **Septopora.** Table III.

5. Zoarium a pinnate stipe without dissepiments; zooecia in two ranges on branch and pinnae. **Pinnatopora.** Table III.

6. Zoarium massive or incrusting; surface with monticules or maculae; zooecia cylindrical; one or more series of vesicles between zooecia. **Fistulipora.** Table IV.

7. Zoarium like Fistulipora, but with large, ramose form; zooecial tubes circular in section. **Cyclotrypa.** Table IV.

8. Zoarium bifoliate, flattened, with mesotheca; zooecia separated by vesicles; apertures oblique, pointing distally. **Meekopora.** Table IV.

9. Zoarium ramose, delicate, elliptical in section, with nonporiferous margins between the two poriferous faces; apertures in four to six linear series on each face of zoarium; vesicles. **Cystodictya.** Table V.

10. Zoarium ramose, very slender; zooecia with long diverging tubes; apertures elliptical, with peristomes; numerous small pits open below apertures. **Streblotrypa.** Table V.

11. Zoarium ramose, slender; mature and immature regions; apertures small; mesopores; numerous small acanthopores. **Batostomella.** Table VI.

12. Zoarium incrusting, massive, or ramose, with mature and immature regions; diaphragms usually present; large acanthopores at angles of cells. **Stenopora.** Table VI.

13. Zoarium usually ramose, mature and immature regions; apertures usually rhombic in young specimens; large and small acanthopores. **Rhombopora.** Table VI.

Batostomalla, Stenopora, and Rhombopora are not very distinct as genera.

Tables of Specific Characters

TABLE 1—GENUS

NAME	Growth	BRANCHES Character	BRANCHES Width mm.	BRANCHES No. in 5 mm.	Carina	Nodes	Dissepiments (Reverse face)
F. mimica	Small, fine	Straight	.19-.25	12-14	Faint	Small	⅓ Wd. of branches
F. limbata	Small, fine	Straight, striated on reverse	.23-.25	12-14	Definite	Small	⅙-⅓ Wd. of branches
F. tenax	Small, fine May be irregular	Straight to flexuous	.2-.25	12-13	Strong	Trace	¼-⅓ Wd. of branches
F. perelegans	Large, regular	Cylindrical, straight. Few bifurcations	25 or more	9-10	Not prominent	Trace	Thin, straight, much depressed
F. spinulosa	Large, regular	Straight, cylindrical	.2- 28	8-10	Definite	Prominent	⅓ Wd. of branches, straight
F. conradi	An undulating foliar expansion	Stout, varying	.3-.4	9 11	Low, rounded wide to thin	Closely placed, small, also on reverse	Broad to narrow, expanded ends.
F. conradi-compactilis	Thick, compact	Thick from reverse to obverse	.3- 4	9-9⅓	Low, rounded	In two faint rows	Stout
F. cyclofenestrata	Large, regular, compact	Rounded on reverse	.25 or more	12-14	Broad	....	Very stout, expanded terminally
F. parvipora	Expanding	Subcarinate on the obverse	.24	9-10	Faint	Trace	Long, straight, ⅓ Wd of branches
F. subrudis	Regular to irregular	Subcarinate on obverse	.35-.45	8	Faint, thin	Inconspicuous	Strong, ⅓ Wd. of branches
F. gracilis	Regular	Slender, straight	25	9-11	Straight, definite	Sharp, conical	⅙-⅓ Wd. of branches
F. kansanensis	Coarse, large	Cylindrical, strong	.35-.4	7-8	Slightly flexuous, prominent	Large, far apart	⅙-⅓ Wd. of branches
F. polyporoides	Regular to irregular, coarse	Strong, straight or flexuous	35-.5	5 or 6	Quite definite	Large	⅓ Wd of branches
F. binodata	Regular to irregular	Stout	.35-.4	6-8	Wide, blunt	Large, in two rows	Stout

FENESTELLA

FENESTRULES (Reverse face)			APERTURES				
Form	Size mm.	No. in 5 mm.	Character	No. to the Fenestrule	Distance Apart	No. in 5 mm.	Peristome
Subquadrangular	.35x 2	12	Large, circular	2	x1	24-25	Definite
Rectangular	.3- 34x .15-.18	12	Large, subcircular or pyriform	2, rarely 3	x1	23-25	Definite, wide
Elliptical	.3x.12	12	Small, circular	2	x1 or more	23-24	Poorly developed
Oblong	.38-.4x .25	9-10	Large	2, sometimes 3	x1 or more	19	Not prominent
Rectangular to short rectangular	.35- 45x .25-.35	8-10	Small, subcircular	2	x2	19 or 20	Faint
Subcircular, varying	vary	9	Circular	2 or 3, usually 2	x1½	20-23	Poorly developed
Circular	.25-.35	8 1-2 or 9	Circular	2	x2	18	Not prominent
Circular to subcircular	.2	12	Medium size, circular to subcircular	2, rarely 3	x1 or more	24	Usually not well developed
Oblong	.5-.55x .31	7½	Very small	3 or 4	x2	25-28	Subconical
Elliptical to elongate-elliptical	.5-.55x .24	6	Medium size, circular	3	x1 or more	17 or 18	Thin
Subrectangular, regular	.65x 25	6	Circular, close to carina	4, rarely 5	x1	23-25	Thin
Subquadrangular	.95x.4	4½	Circular, medium size	4 or 5	x1 or more	18	Present
Subquadrangular, varying	.9-1.25x .45-.6	3½ or 4	Subcircular, in 2 or 3 ranges	4-6	x1 or more	16-18	Not prominent
Subelliptical, varying	.6-.7 x.35	6 or 6½	Circular	3 or 4	x1½	18-20	Incomplete, thin

TABLE II.—GENERA POLYPORA,

NAME	Growth	BRANCHES				Nodes	Dissepiments
		Obverse face	Reverse face	Width mm.	No. in 1 cm.		
P. elliptica........	Regular, large	Convex to subcarinate	Convex to subcarinate	5	12-16	Small to large	Stout in old growth
P. whitei..........	Irregular, small	Convex, rather rough	Quickly rounded	5	12-16	Few, small	Slender, ends expanded
P. spinulifera	Regular	Convex	Usually quickly rounded	.5-.8	12 or 13	Small, many	Stout
P. bassleri........	Regular or irregular	Convex to quickly rounded	Subcarinate or convex	.6-1	8-10	Quite large, scattered or central	Usually long
P. reversipora	Regular	Quickly rounded	Slowly rounded, slightly flexuous	.7-.9	10	Very large	Stout on reverse
P. ulrichi..........	Usually spreading	Subcarinate	Convex or narrowly rounded	Avg. .9	7-9	Large, on center of branch	Much depressed on obverse
P. stragula..... .	Regular	Straight	Sagged	....	7 or 8 (?)	....	Stout
P. oestriensis	Fairly regular	Subcarinate to quickly rounded	Subcarinate or convex	.6-1	8	Central row on obverse	Usually slender
P. submarginata..	Irregular. Bifurcations frequent	Subcarinate	Narrowly rounded, flattened sides	1	6 or 7	Central row on obverse	Resemble branches on reverse
P. crassa..........	Irregular, large, fan-shaped	Convex	Strongly rounded	1. or more	5 or 6	Smooth (?)	Stout, vary in length
P. remota	Evenly spreading	Evenly convex	Evenly convex	.7-1	7	Smooth	Thin
T. pinnatus........	Pinnate to bifurcate	Slowly convex	Convex	1-2	......	....	Not present
T. sevillensis.....	Diffuse	....	Rounded	.35-.65	....	On reverse face	Not present
T. palmatus	Palmate	....	Evenly convex	.65	......	....	Not present

AND THAMNISCUS

FENESTRULES			APERTURES					Additional Characters
Form (Reverse)	Size mm.	No. in 1 cm.	Character	No. of Ranges	No. to the fenestrule	No. in 5 mm.	Peristome	
Elliptical	.6x.3	10-12	Medium size	2-5, usually 3	3 or 4	18-20	Thin to thick	Nodes elevate from faint longitudinal lines
Subovate	.8x.3 (obverse)	9 or 10	Circular	2-4	4	19	Thin to thick, may be elevated	Faint longitudinal lines occur between the apertures
Oval	.5-.75x.2 (obverse)	10	Circular, small	4	4	19-20	Well developed	Spines are distributed among the apertures
Oblong	.9-1x .45 (obverse)	7-9	Small to large	3-6	5 or 6	19-20	Perfect, on apertures of lat. ranges	Reverse of irregular growth resembles P. submarginata
Elliptical	.9x.5	8	Sub circular	4-6	4	16	Thin, incomplete	Pores on the reverse face
Subelliptical	1.15-1.30 x 4-.5 (obverse)	6-7	Small	4-7	5	16-17	Thin, incomplete	Zooecia very large A variety has smaller and more convex branches
Oblong	....	6	Sma'l	4-6	....	......	....	Species poorly defined
Subovate	1.4-1.5 x.5-6 (reverse)	6	Circular, pustuloid	3-7	5	15	Complete, elevated	Apertures two diameters or more apart
Oblong-oval	2.x.8-1 on reverse	4 or 5	Circular	5-8	6-8	14-17	Fairly distinct	Perfect branches subpentagonal
Irregular-oblong	Avg. 2.6x1.1	3	Circular,	4-8	8 or more	20	Not prominent	Apertures usually do not extend to the margin of branch
Oblong	2.5x-.7-.8 (inside)	3 or 3½	Circular, small	4-6	5 or 6	12-13	Slightly elevated	Apertures 3-5 diameters apart in each series
Not present	....	......	Circular, pyriform when worn, small	3-8	... .	15	Horse-shoe-shaped	Pinnae about 1.5mm. long and alternately placed
Not present	....	......	....	3-4	....	14-15	....	Bifurcations at short intervals
Not present	....	......	....	3-5	.....	13	....	... .

TABLE III—GENERA SEPTOPORA,

NAME	Growth	BRANCHES Character	BRANCHES Size (mm.)	BRANCHES No. in 1 cm.	Fenestrules
S. decipiens.......	Pinnate stipe	Midrib, pinnae and a few dissepiments	Midrib .5-.9	Pinnae (one side) 12-13	Very few
S. multipora.....	Large pinnate frond	Midrib, pinnae and dissepiments	Midrib .5-.7 Pinnae .3	Pinnae (one side) 8	Very few
S cestriensis.....	Fenestrated, small	Bifurcate	Avg. .55, varying	12	Subcircular, small
S. biserialis	Fenestrated, large	Nearly parallel	Avg. .5, varying	10	Transversely oblong
S. biserialis-nervata	Fan-shaped, large	Primary and secondary	Avg .5 or more	9	Transversely oblong
S. pinnata	Pinnate frond	Midrib and lateral branches	.5-.7	10	As wide as branches
S. robusta	Robust	Convex on reverse, large	Avg. .7-.8	5-8	Large, obscured in old growth
P. trilineata.... .	Pinnate	Midrib and pinnae	Midrib .5. Pinnae .23-.25	Pinnae (one side) 12	Not present
P. pyriformipora.	Pinnate	Midrib and pinnae	Midrib 5 Pinnae .25	Pinnae (one side) 12	Not present
P. youngi	Pinnate	Midrib and pinnae	Midrib .55	Pinnae (one side) 13	Not present

AND PINNATOPORA

Apertures: Character	Apertures: No. to the Fenestrule	Apertures: No. on each dissepiment	Apertures: No. in 5 mm.	Pores on reverse face	Additional Characters
Suboval, large. Accessory pores	....	(?)	16 or 17	Few	Pinnae short
Subcircular	5 or 6 for each pinna	(?)	17	Few	Few dissepiments
Circular. A few accessory pores	4	4; in 2 ranges	20-23	Circular, few	Dissepiments direct. Reverse pores usually near the ends of dissepiments
Subcircular. Accessory pores	4	3-8. In 2 ranges	20-21	Few	Spines and carina on obverse face
Subcircular. Accessory pores	4	3-8 in 3 ranges	20-21	Few	Spines and carina on obverse face
Circular. Accessory pores	4	2-8	19-20	Few	Lateral branches usually separate at less acute angles than in S. biserialis-nervata
Large. Accessory pores	5-7	7-25. In 3 ranges	22-23	Large, numerous	Prominent carina and spines on obverse face
Circular	3 for each pinna	....	17 or 18	None	Midrib cylindrical and striated on reverse. There is a faint trilineate carina on the obverse
Circular, small	3 for each pinna	....	18	None	Midrib tuberculated on reverse. Distinct carina and nodes
Subcircular	2 for each pinna or lateral branch	....	13	None	Reverse broadly convex. Lateral branches short

TABLE IV—GENERA FISTULIPORA,

NAME	Growth	Surface of Zoarium	Zooecia	Apertures. Form. Diameter
F. nodulifera	Incrusting, usually thin	With nodes or smooth	Short	Subcircular. .25-.3 mm.
F. carbonaria	Discoid or massive	Maculae or smooth	Usually long	Subcircular to elliptical .35 mm.
F. carbonaria-nebrascensis	Large, massive, irregular	Monticules and maculae	Long	Subcircular. Avg. .28 mm.
C. (?) barberi	Ramose, branches subcylindrical	Small, elevated maculae	Curve from axis of branch	Subcircular, .3 mm. or more
M. prosseri	Bifoliate. Branches flattened	Low maculae	Curve gradually from mesotheca to surface	Ovate, .16-.2 mm.

TABLE V—GENERA CYSTODICTYA,

NAME	Growth	Width of Branch	Non-poriferous margins	Ridges
C. anisopora	Bifurcating stem	1.-1 5	Unequal	Transverse
C. inequamarginata	Bifurcating stem	1	Unequal	Obscure, longitudinal
C. lophodes	Bifurcating stem	1.-1.5	Small, equal	Definite, longitudinal
S. prisca	Ramose	.5-1 or more	Not present	Longitudinal, sinuous

CYCLOTRYPA, AND MEEKOPORA

Lunarium	Diaphragms	Vesicles	Additional Characters
Fairly definite	Usually wanting	Small, numerous	Interspaces as wide as the apertures. Vesicles generally in more than one series
Shown	Numerous	Large	Apertures less than their diameter apart. One range of vesicles between zooecia
Prominent	Quite plentiful	Large, vary in size	Mastoid-like nodes occur on the zoarium
Faint to strong lip	Present	Of medium size	Interspaces not as wide as the apertures
Not prominent	Few	Small, numerous.	Apertures small. Interspaces thick

AND STREBLOTRYPA

APERTURES				Lunarium	Additional Characters
Form	Size	No. of rows	No. in 5 mm.		
Subcircular	Large to small	4-6	6¼ or 7 (largest)	Faint	Stem subelliptical in section
Subcircular	Small	3 or 4	10 (largest)	Faint	Stem subelliptical in section, one margin being acute, the other convex
Subelliptical	Large, nearly equal	4 or 5	8	Definite	Stem subelliptical to subcircular in section
Oval	Large	Varies with age	11	....	Numerous pits, in two or three rows, occur below the apertures. Zooecia long and gradually curved

TABLE VI—GENERA STENOPORA,

NAME	Growth	Surface of Zoarium	Zooecia	Diaphragms	Acanthopores
S. spinulosa	Incrusting	Montiferous	Short	Absent (?)	Large and small
S. tuberculata	Incrusting	With spines	Short	Present	Large at cell-angles
S. heteropora.....	Massive or incrusting	Montiferous	Vary in size	5-8 in each tube	Medium size, few, at cell-angles
S. carbonaria	Ramose, with subcylindrical branches	Smooth	Walls monilliform	Several	Large
S. carbonaria-conferta...........	Ramose	Smooth	Walls monilliform	Several	Large
S. distans.........	Incrusting or ramose	Low monticules or smooth	Walls thick	3-7 in each tube	Large and small
S. (?) polyspinosa	Ramose or incrusting	With spines	Long Mature and immature regions	Few	Many, of medium size, some large
R. lepidodendroides...	Ramose or incrusting	Smooth or montiferous	Mature and immature regions	Very few, most in old growth	Large and small
B. leia.............	Ramose, branches slender	With small spines or smooth	Very thin mature regions	Few	Many small. A few large

RHOMBOPORA, AND BATOSTOMELLA

Mesopores	Apertures			Additional Characters
	Form	Diameter. mm	No. in 5 mm.	
....	Subangular	.2- 27	15	Large acanthopores occur at and between the cell-angles
Few	Polygonal	.21-.25	15	Apertures more or less in series
None (?)	Polygonal	.21- 4	14 or 15	Interspaces thin. Walls loosely coalesced
Few or wanting	Subcircular to angular	.23	17	Diameter of branches 10-15 mm. Interspaces thick to thin
Few or wanting	Subcircular to angular	.23	17	Beads of moniliform walls very close-set
A good many	Subcircular	Avg. .25	15 or 16	Interspaces unusally wide
Several	Subcircular to polygonal	.25- 3	14	Interspaces thin when not worn. The smaller acanthopores longer than in other species
....	Subcircular	2-.25	12 or 13	Apertures open into rhombic vestibules in some well-preserved specimens
Small	Subcircular to polygonal	.14- 16	12-15	Interspaces thick in old growth; may be thin in young specimens

PLATES

1 — 21

PLATE I

Fistulipora nodulifera *Meek*

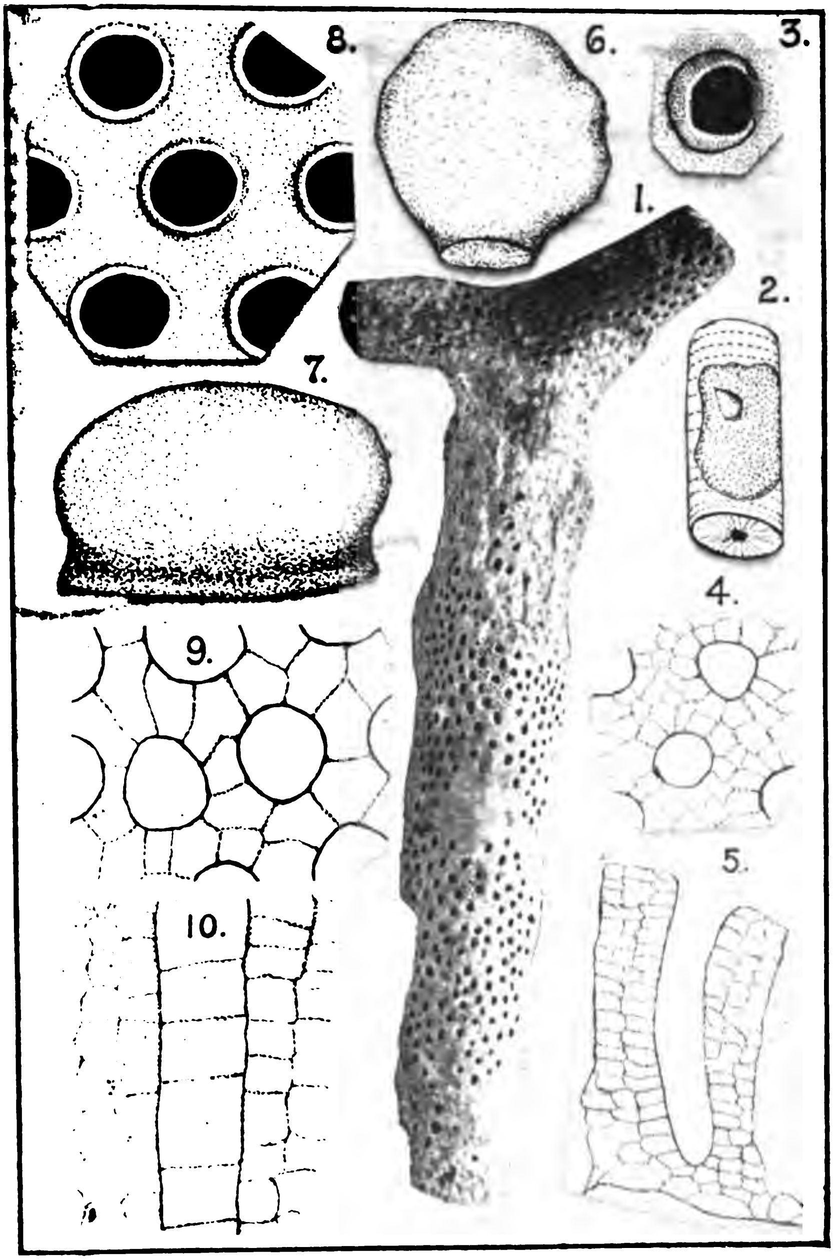

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PLATE II

Fistulipora carbonaria-nebrascensis *Condra*

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Cyclotrypa (?) barberi *Ulrich*

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Fig. 5. Surface enlarged, x 22, showing pustules ....
Fig. 6. Surface enlarged, x 6 ....
Fig. 7. Vertical section of a small branch, x 12.....................
Fig. 8. Transverse section, x 22....................................
Fig. 9. Transverse section from near the center of the stem, x 22....

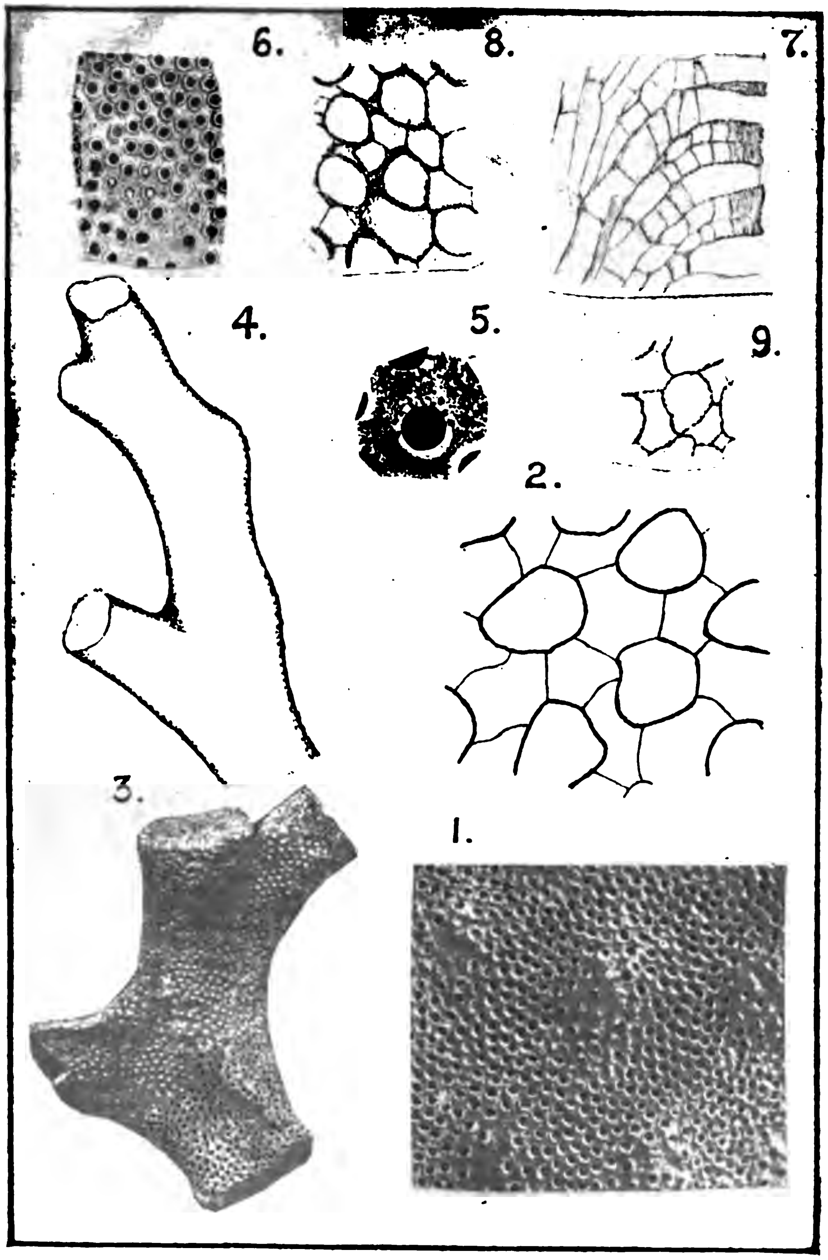
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PLATE III

Meekopora prosseri *Ulrich*

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Batostomella leia *Condra*

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Fig. 13.	Tangential section, near the surface, x 40	
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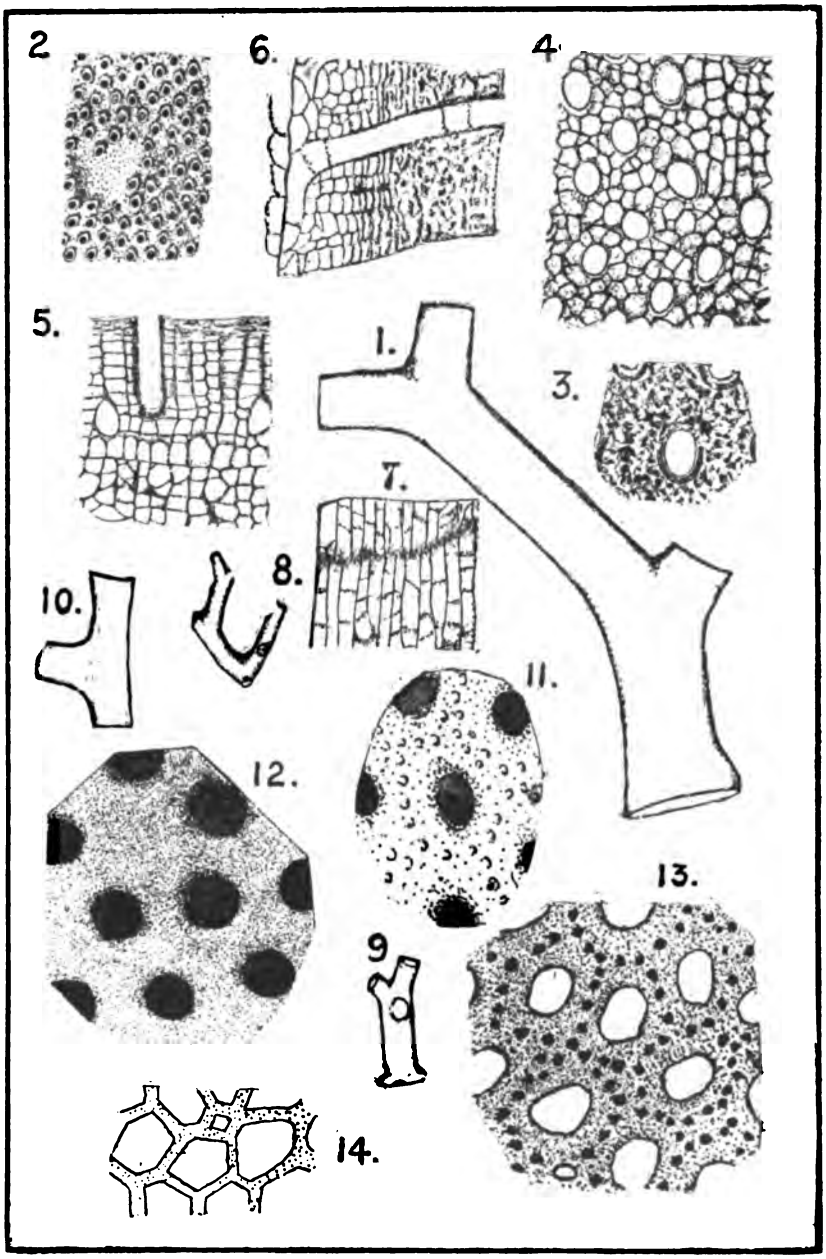
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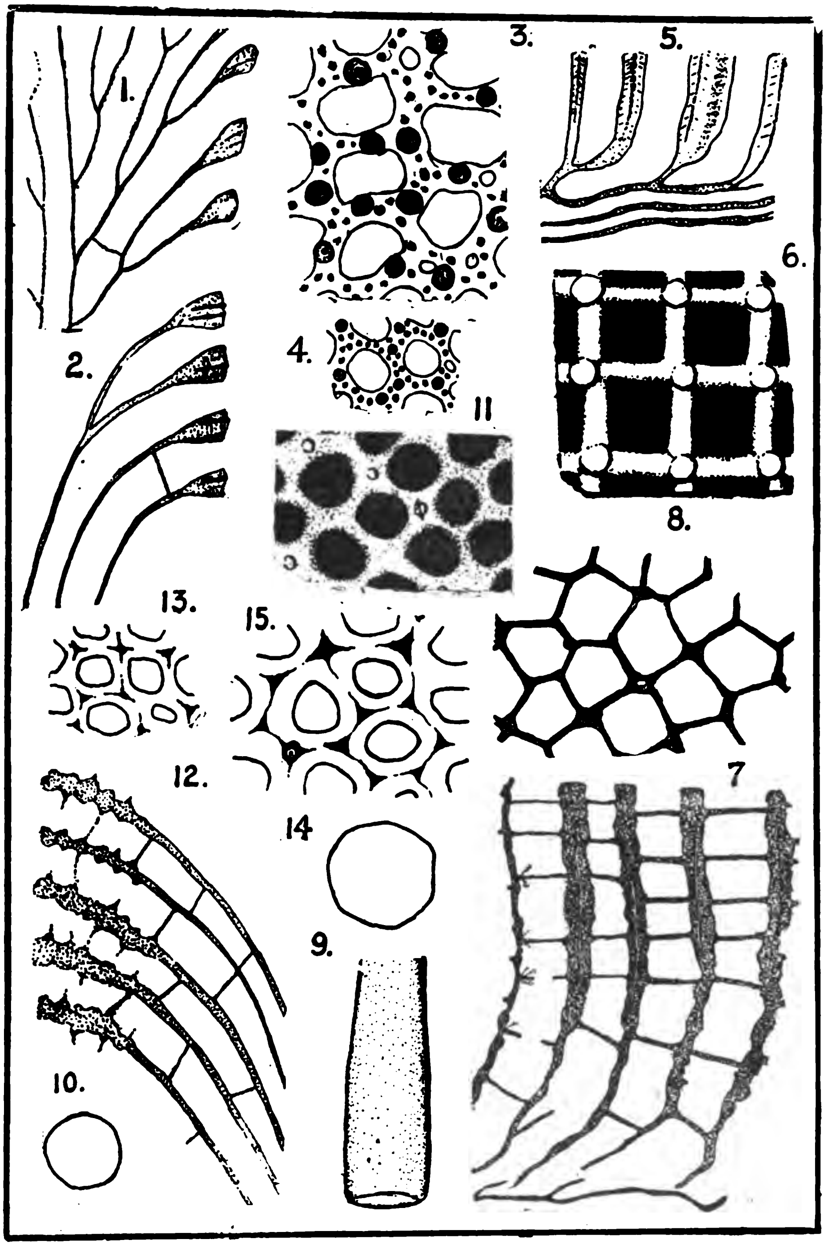
PLATE IV

Batostomella leia *Condra*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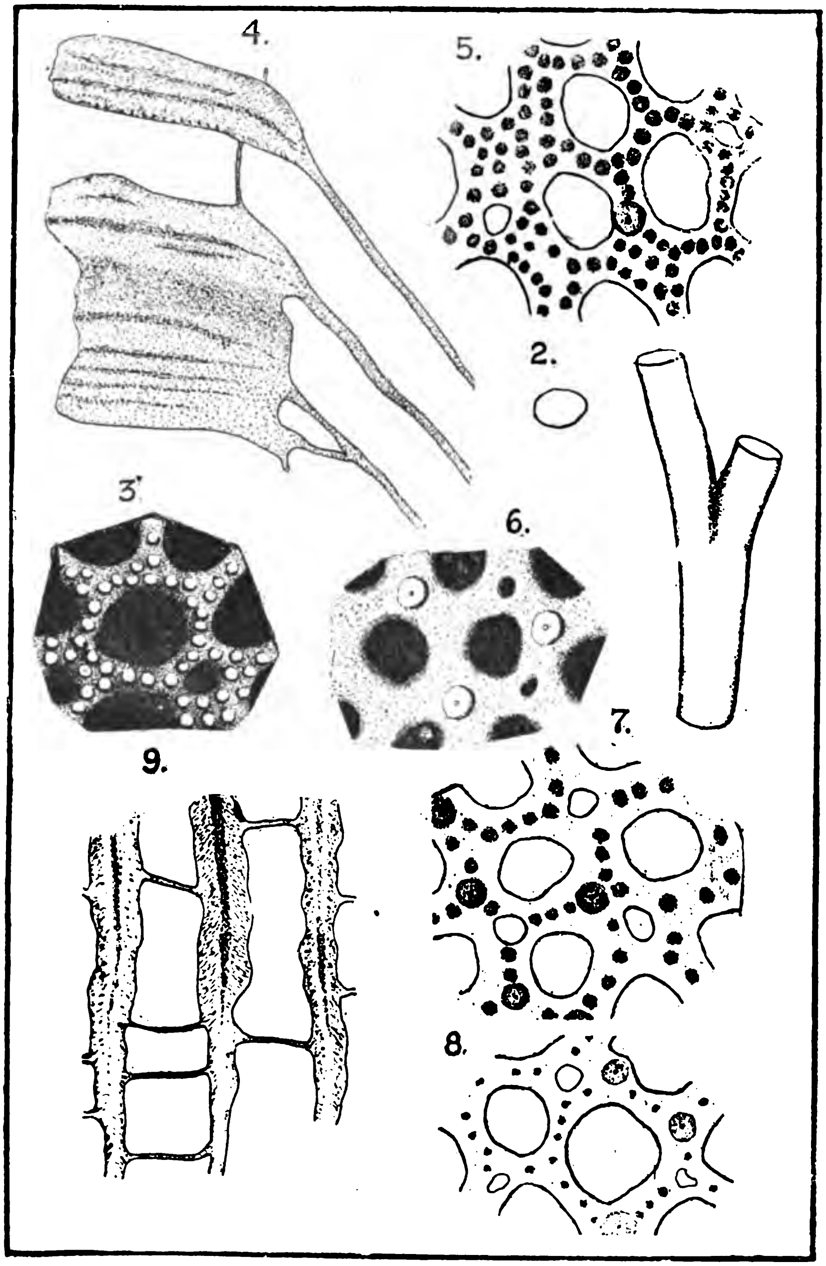
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Stenopora (?) polyspinosa *Condra*

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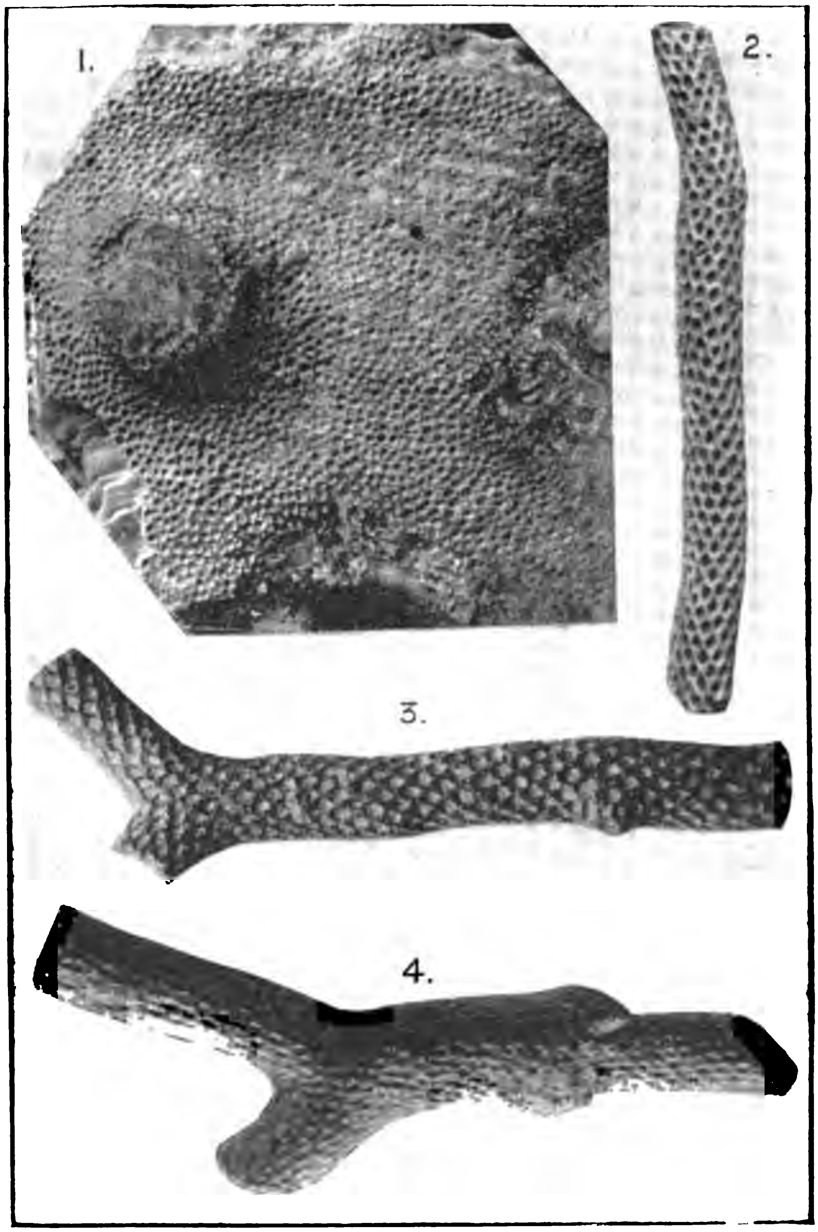
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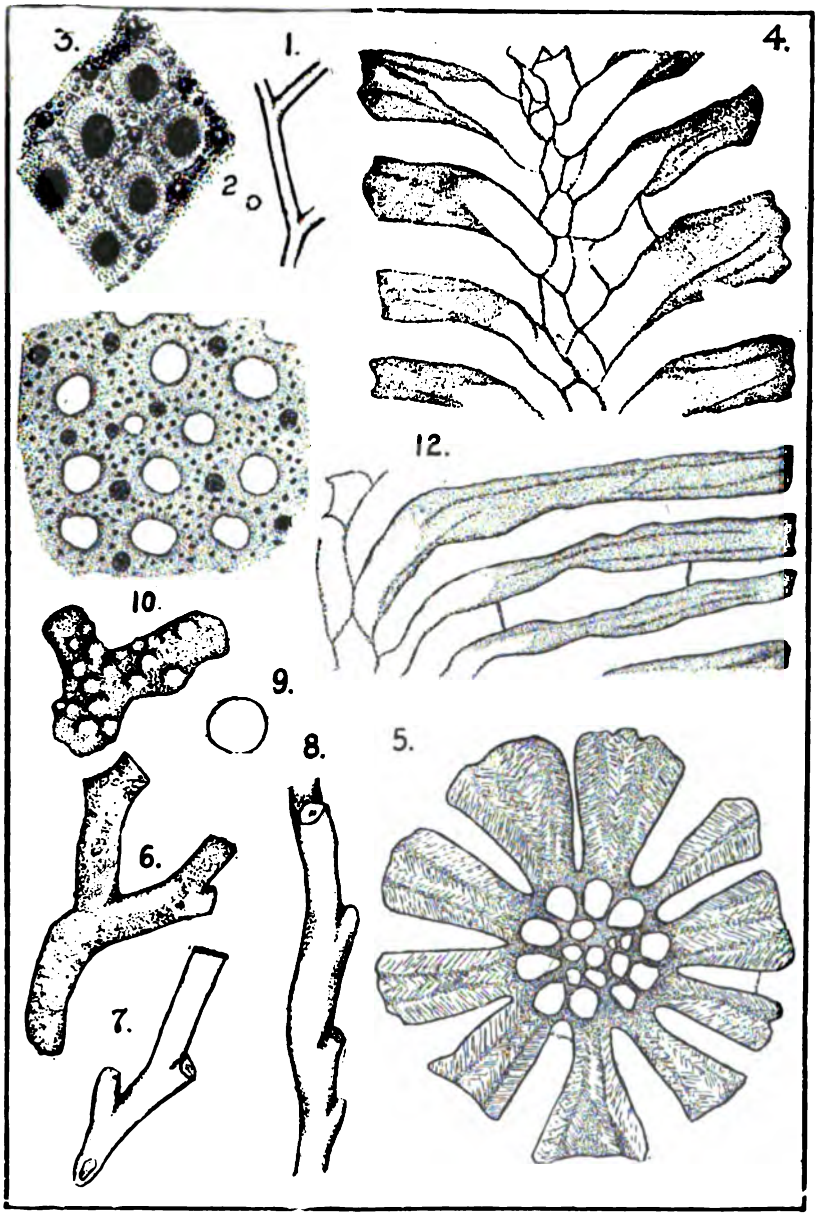
Rhombopora lepidodendroides *Meek*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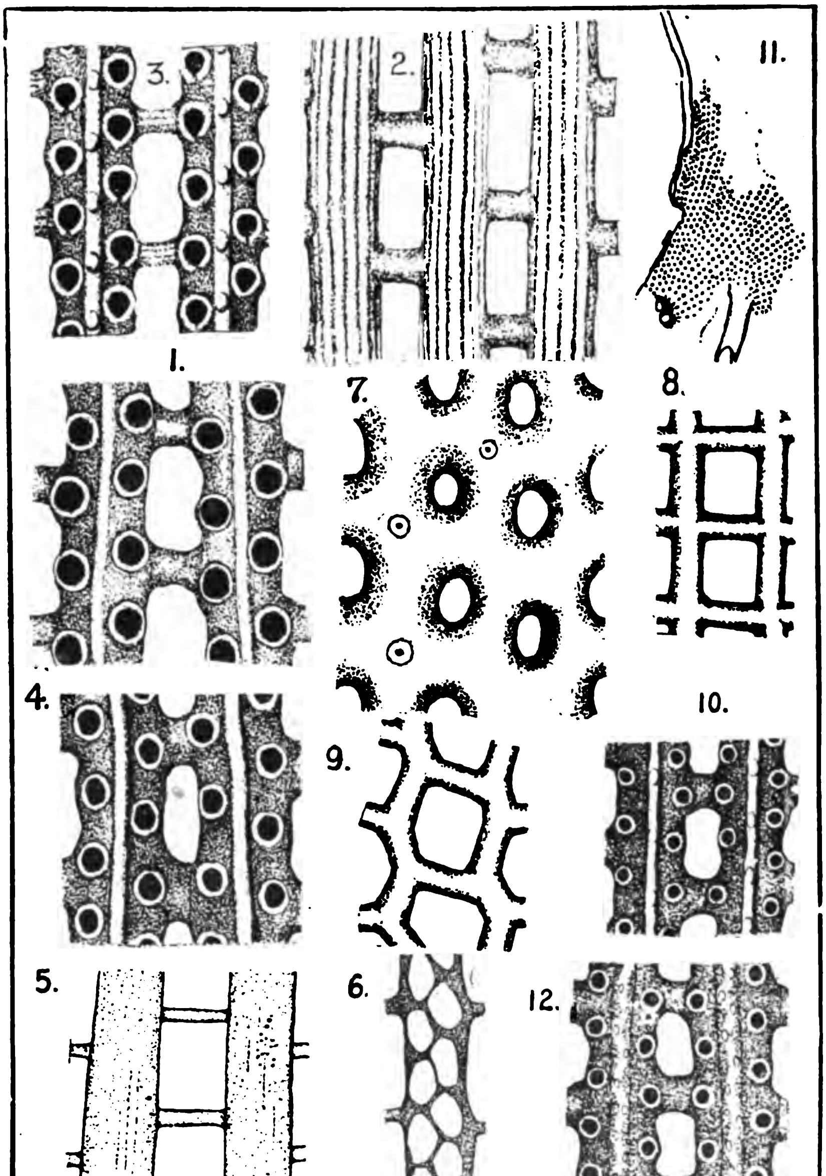
Fenestella mimica *Ulrich*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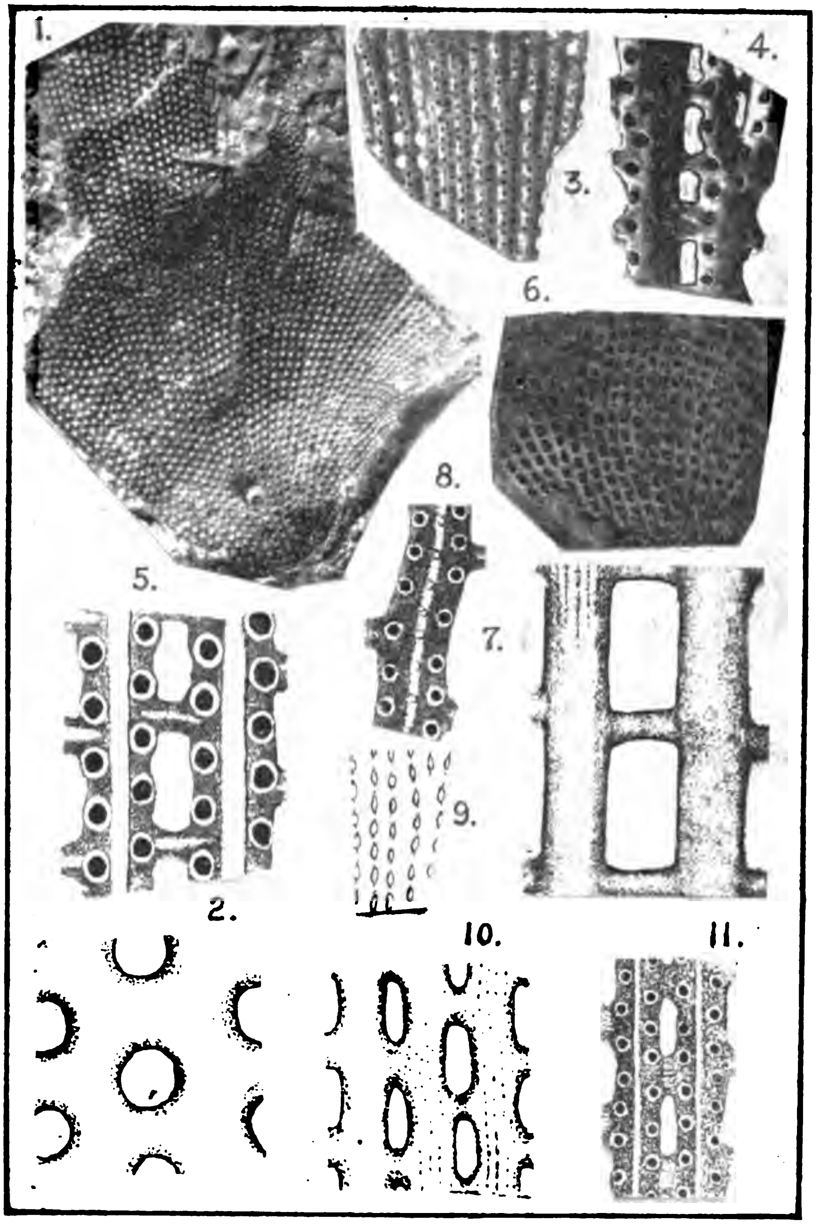
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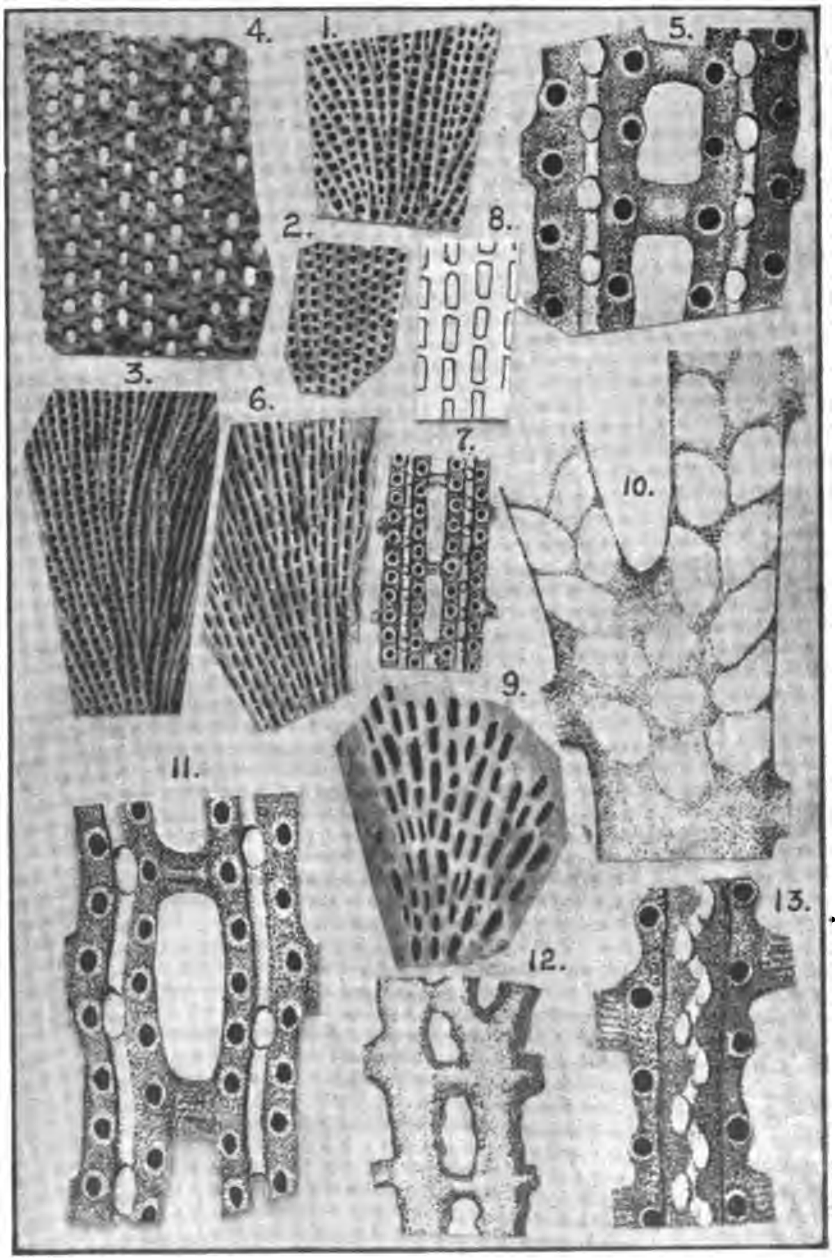
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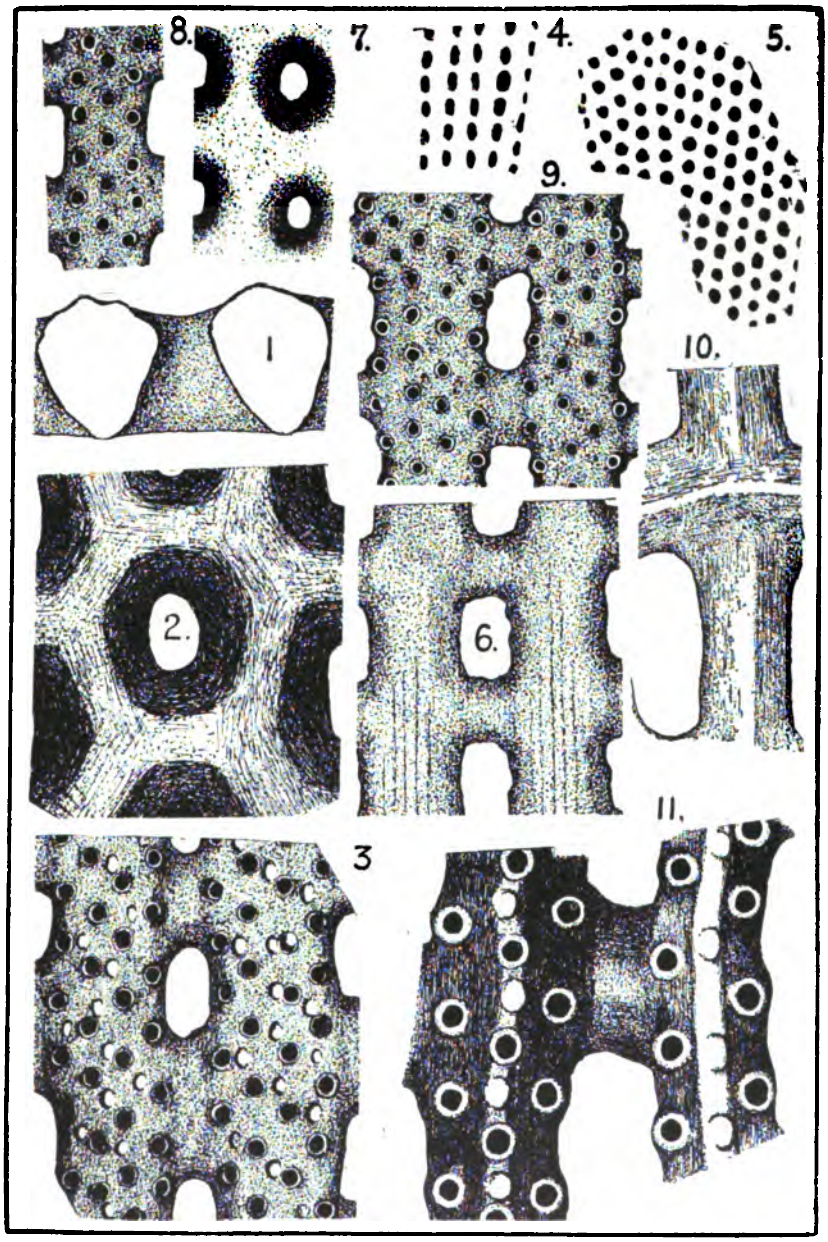
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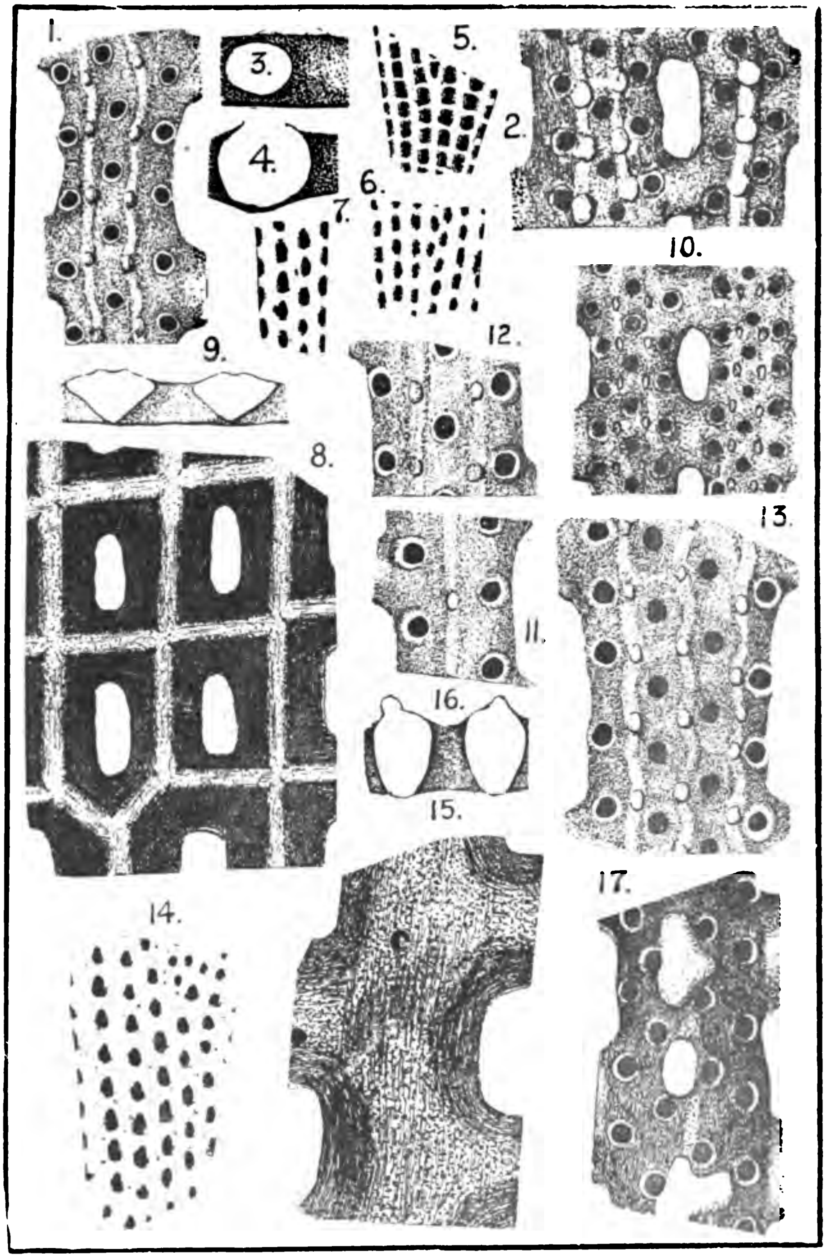
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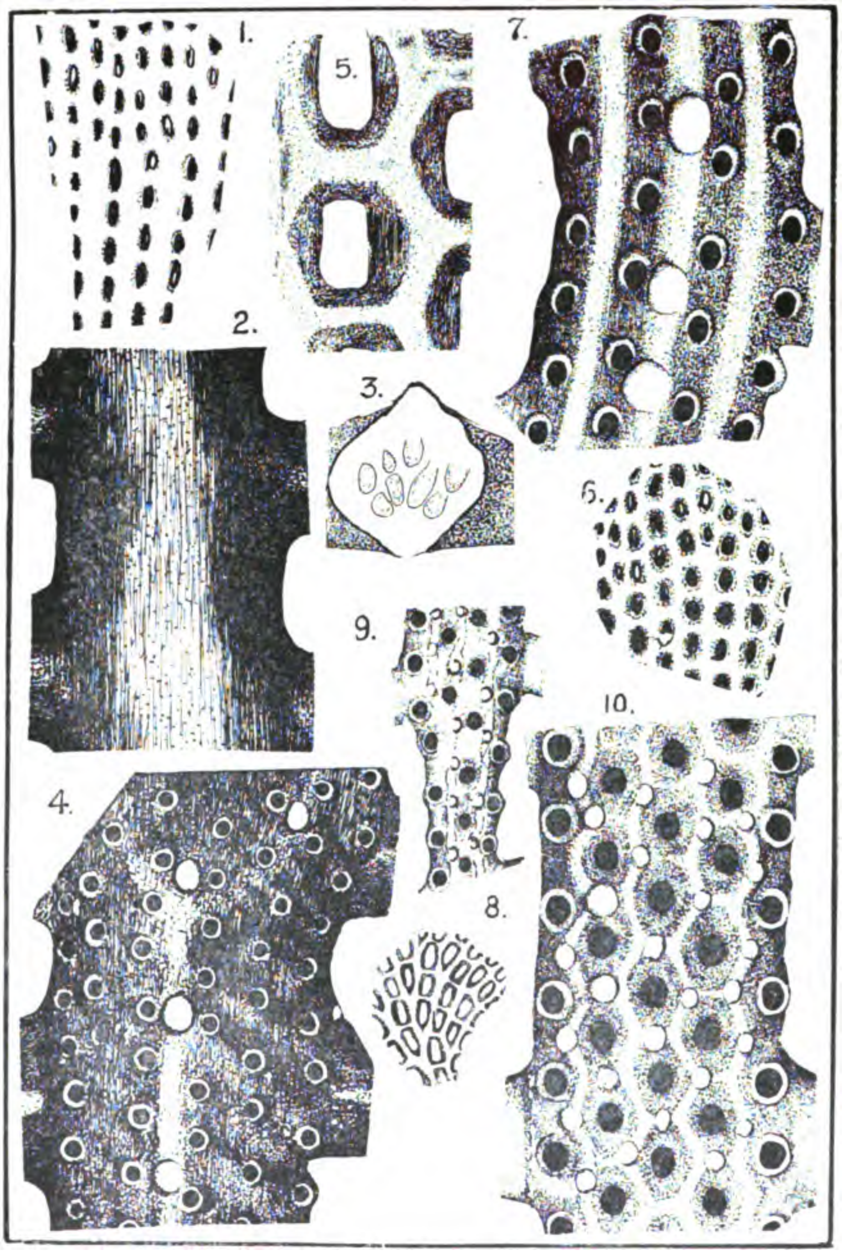
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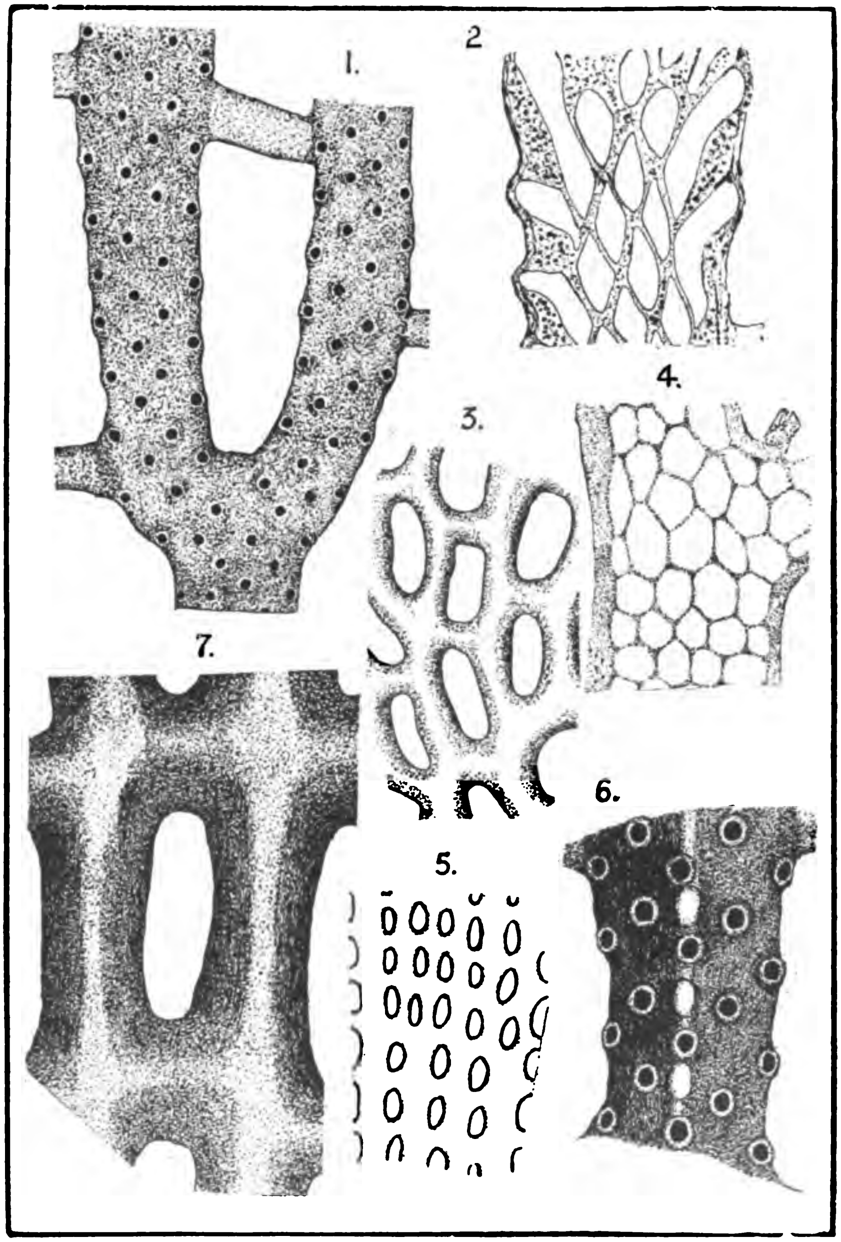
Polypora remota *Condra*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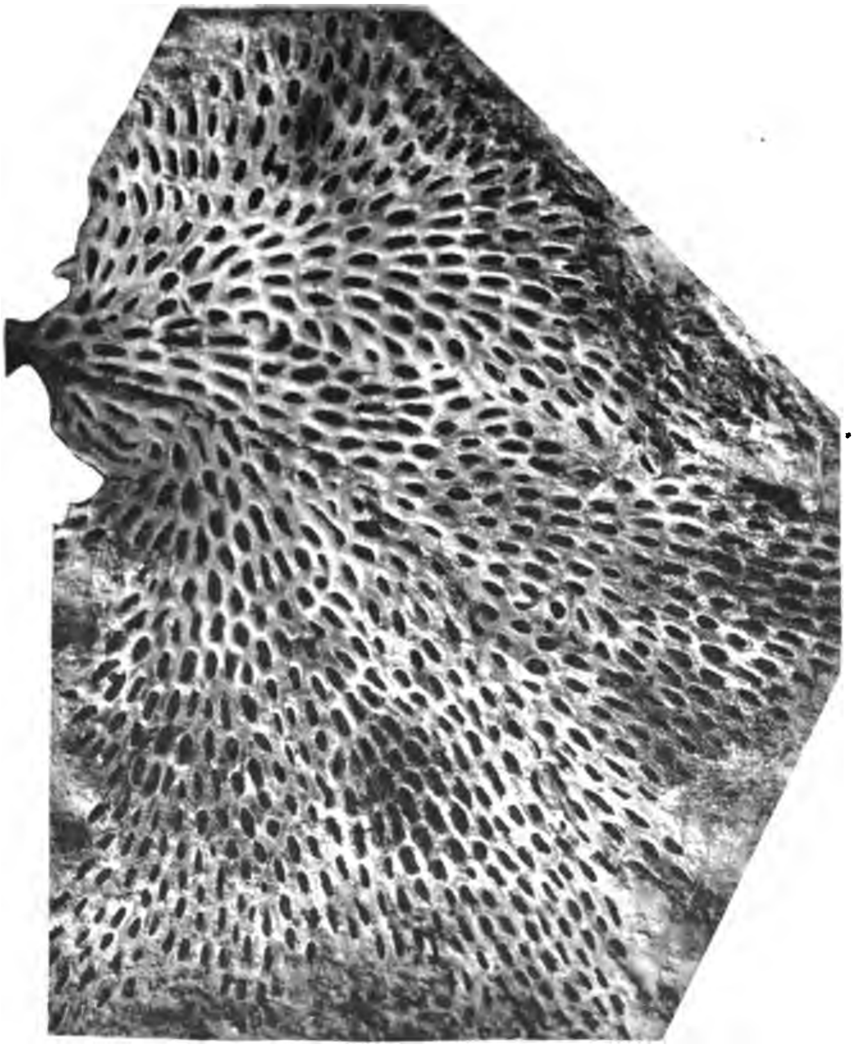

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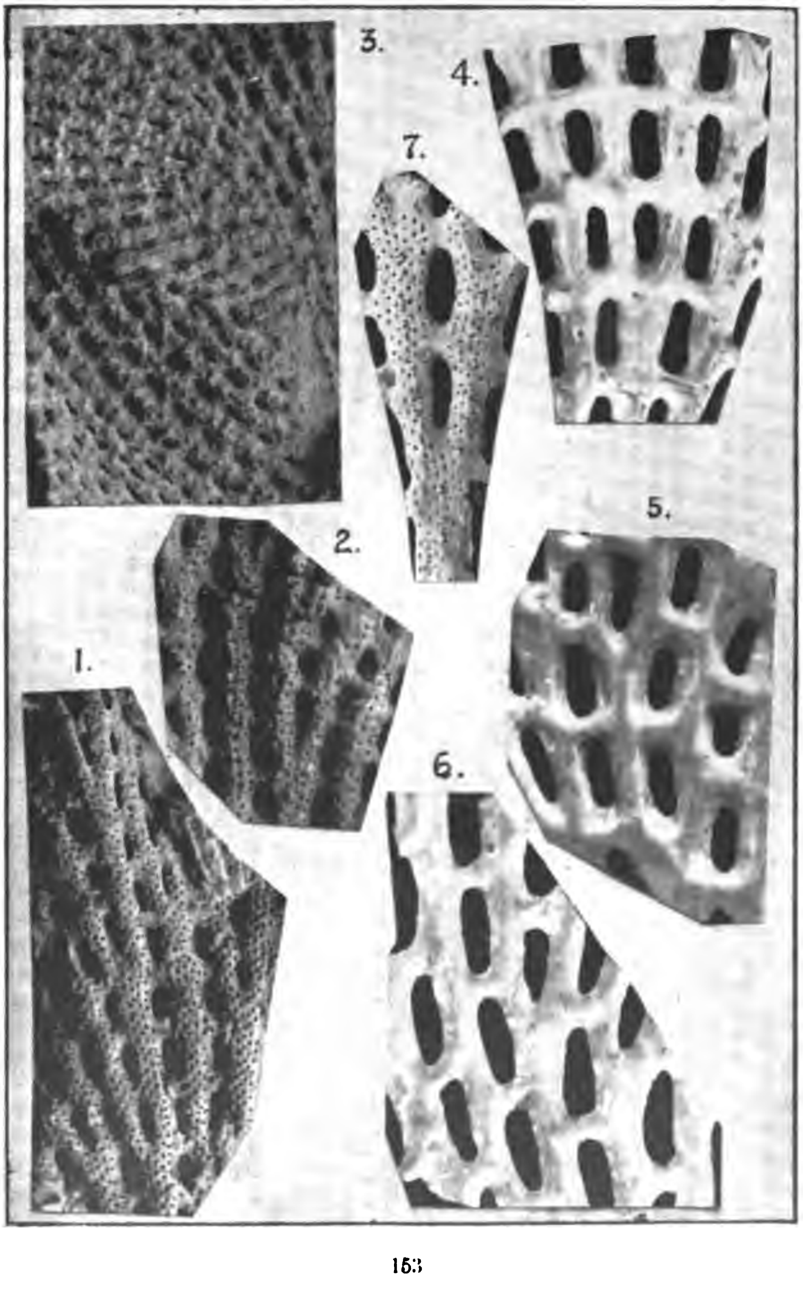
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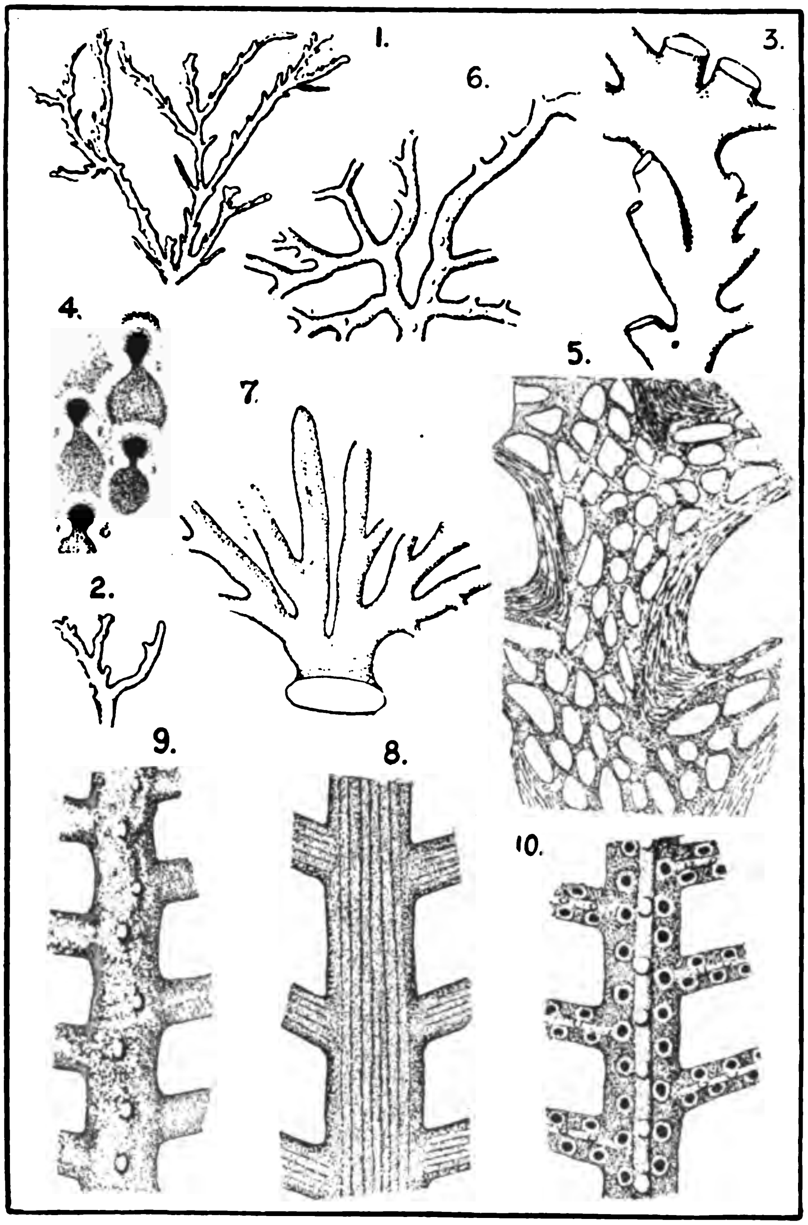
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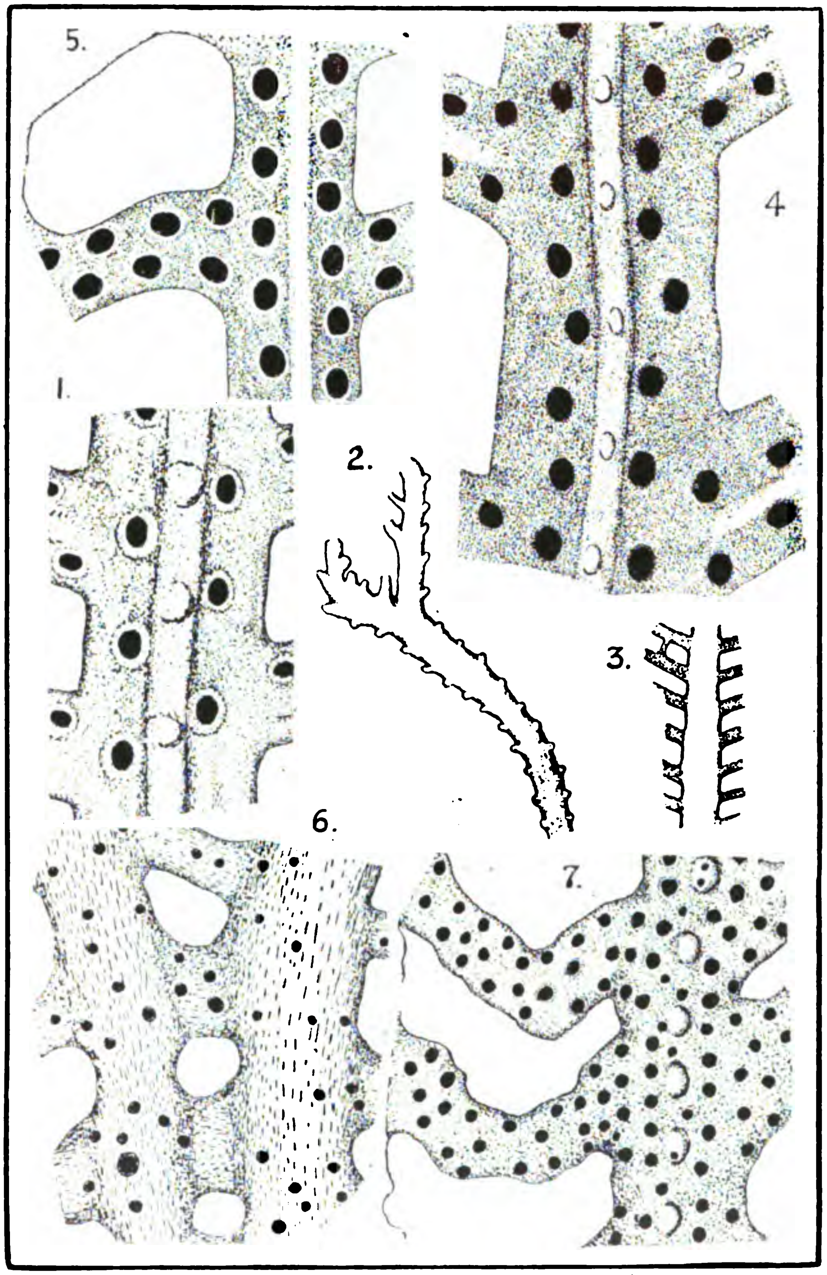
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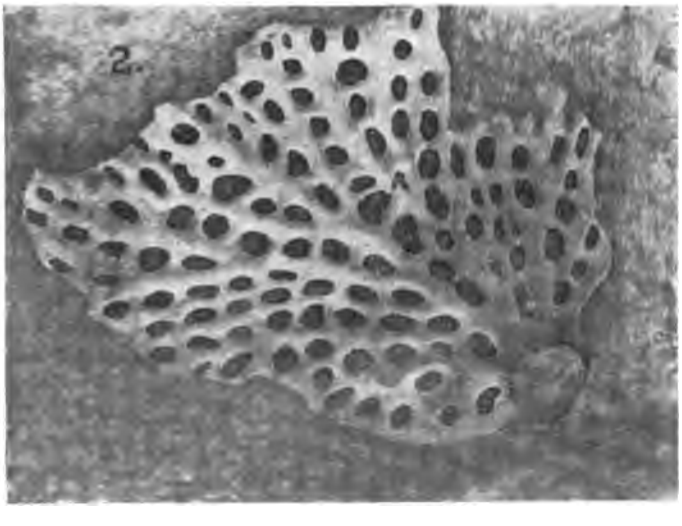
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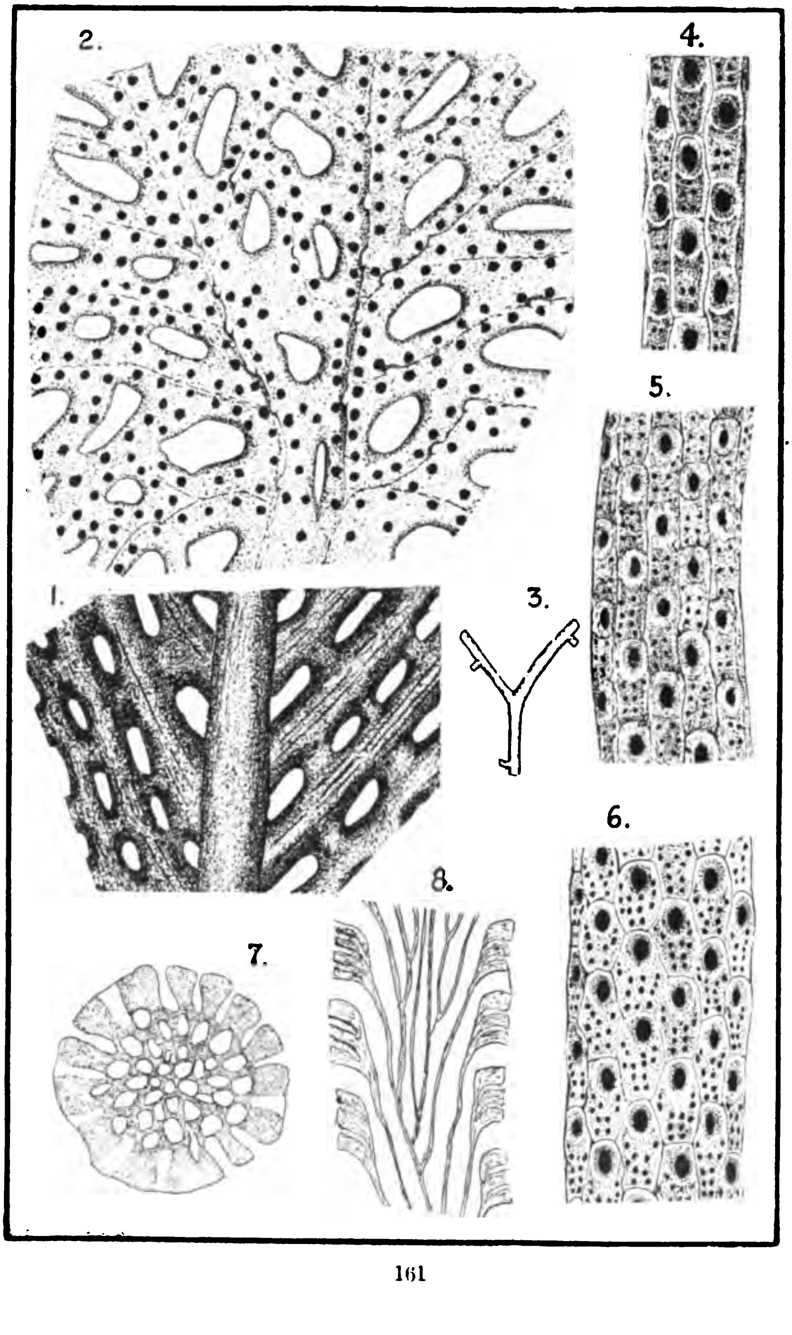
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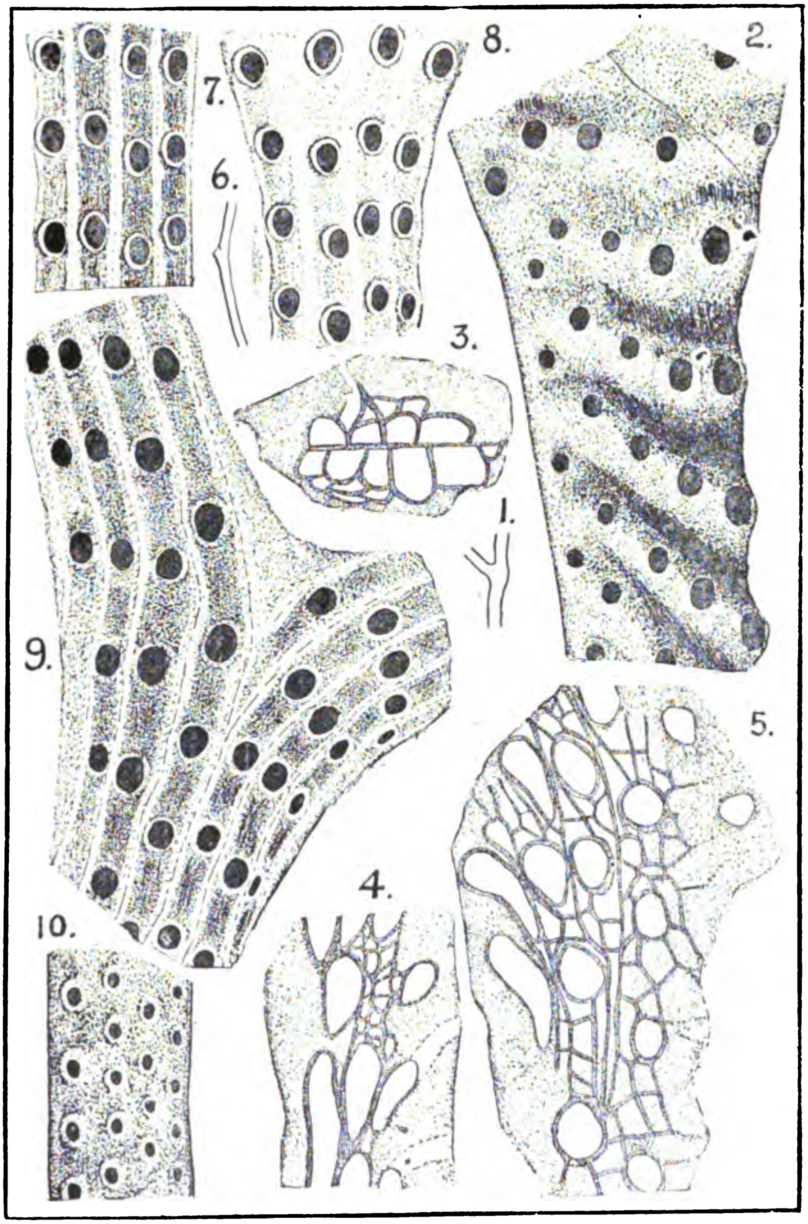
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Nebraska—Geological Survey.

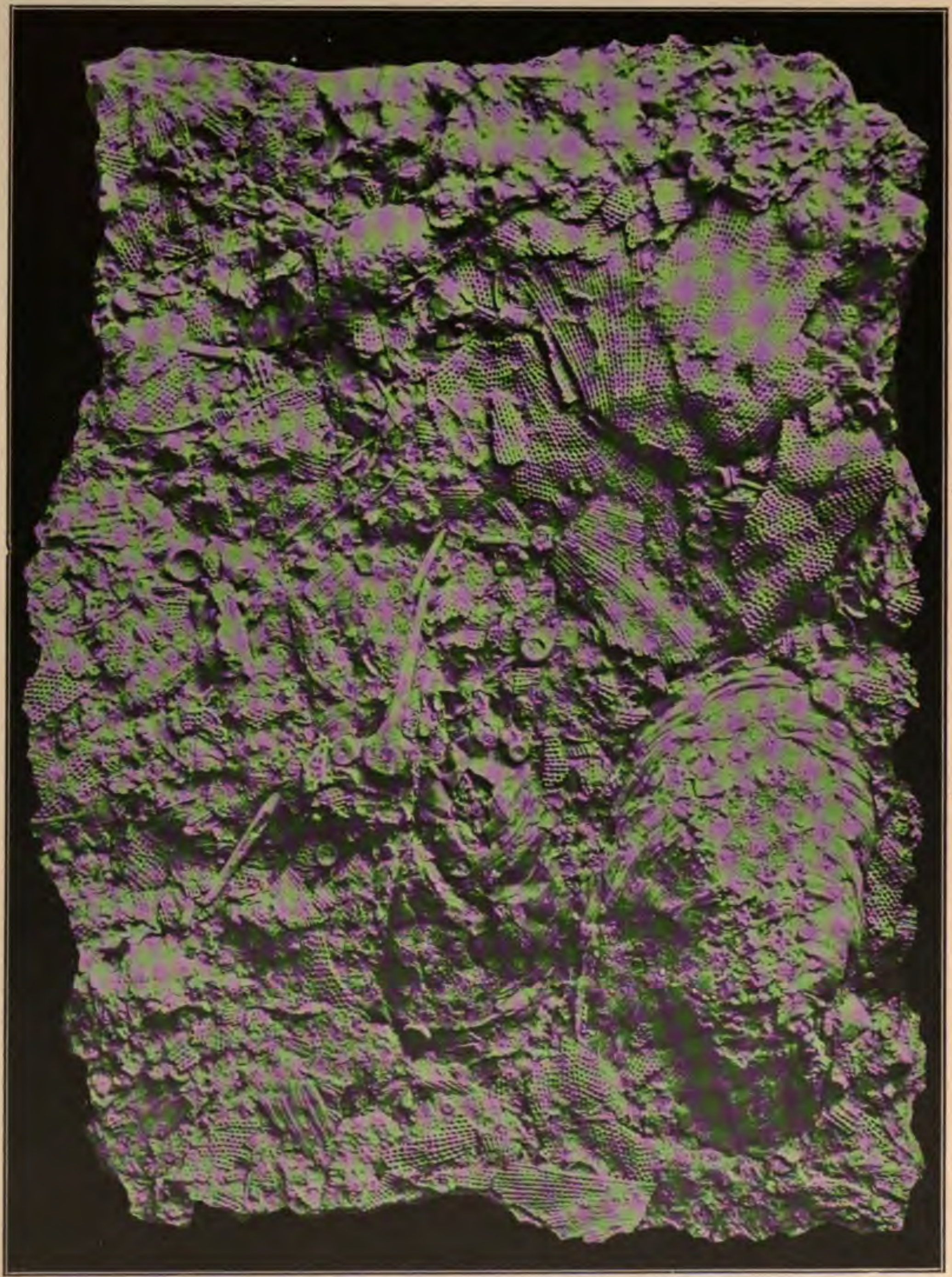
The geology of Cass county, Nebraska, by Elmer Grant Woodruff, 171-302 [131] p.O. Lincoln, Neb., 1904.(Publication of the survey, v. 2, part 2).

Nebraska—Geological Survey.

The geology of Cass county, Nebraska, by Elmer Grant Woodruff, 171-302 [131] p.O. Lincoln, Nebr., 1904. (Publication of the survey, v. 2, part 2).

Woodruff, Elmer Grant.

The geology of Cass county, Nebraska; 171-302 [131] p.O. Lincoln, Nebr., 1905. (Nebraska-Geological survey, v. 2, part 2).



A BIT OF ANCIENT SEA BOTTOM—CASS COUNTY CARBONIFEROUS.

NEBRASKA

GEOLOGICAL SURVEY

ERWIN H. BARBOUR, STATE GEOLOGIST

VOL. II

PART TWO

THE GEOLOGY OF CASS COUNTY NEBRASKA

BY

ELMER GRANT WOODRUFF

HAYES PRINTING CO.
OMAHA, 1906

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WITH THE ASSISTANCE AND COOPERATION OF THE UNITED STATES GEOLOGICAL SURVEY

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LETTER OF TRANSMITTAL

To His Excellency, John H. Mickey,
Governor of the State of Nebraska

Sir:—I have the honor to transmit herewith a manuscript entitled, "The Geology of Cass County, Nebraska," prepared by Elmer Grant Woodruff, an assistant in the Department of Geology, in the University of Nebraska, it being his thesis for the Degree Master of Arts.

Very respectfully,
ERWIN HINCKLEY BARBOUR,
State Geologist.

THE UNIVERSITY OF NEBRASKA,
DEPARTMENT OF GEOLOGY,
LINCOLN, DECEMBER, 1904.

CONTENTS

ILLUSTRATIONS

INTRODUCTION.

Much of the material for this paper has been collected during the last ten years, while in the latter half of the period many of the direct observations here recorded have been made.

Cass county being the boyhood home of the writer he early began observations, some of which, modified by the teachings of geologists, are herein presented.

This paper is intended primarily for farmers and teachers, hence the method of presentation is as non-technical as is consistent with accuracy. It is the first of a series of county reports which the Nebraska Geological Survey is now undertaking, and which will be published as the investigations are completed. Some counties have already been partially investigated.

Most of the material presented and the major part of the mapping is the result of work conducted while the writer was connected with the State Geological Surveys of 1900 and 1901. A portion of the summer of 1903 was also spent in this same field. Many field trips, each of but a few day's duration, have been made to different localities for the purpose of studying special problems.

The actual field work was accomplished partially by train, but chiefly by wheel and on foot. The Burlington and Missouri River Railroad has kindly furnished transportation which has assisted materially.

The incompleteness of the work will cause less criticism when it is known that until very recently this work could only be made a secondary consideration, and even now that appropriations are available and greater opportunities afforded, an insufficiency of funds requires the omission of much which might otherwise be presented.

The early investigation was supported almost entirely by private funds furnished by the Hon. Charles H. Morrill and much of the later work is due to his munificence. During the last year the state has assisted in compiling and publishing such work. All specimens, maps, etc., were collected at the University of Nebraska. where the data were compiled and where, under the direction of the State Geologist, the work was completed. Specimens, maps and notes may be found at the University of Nebraska.

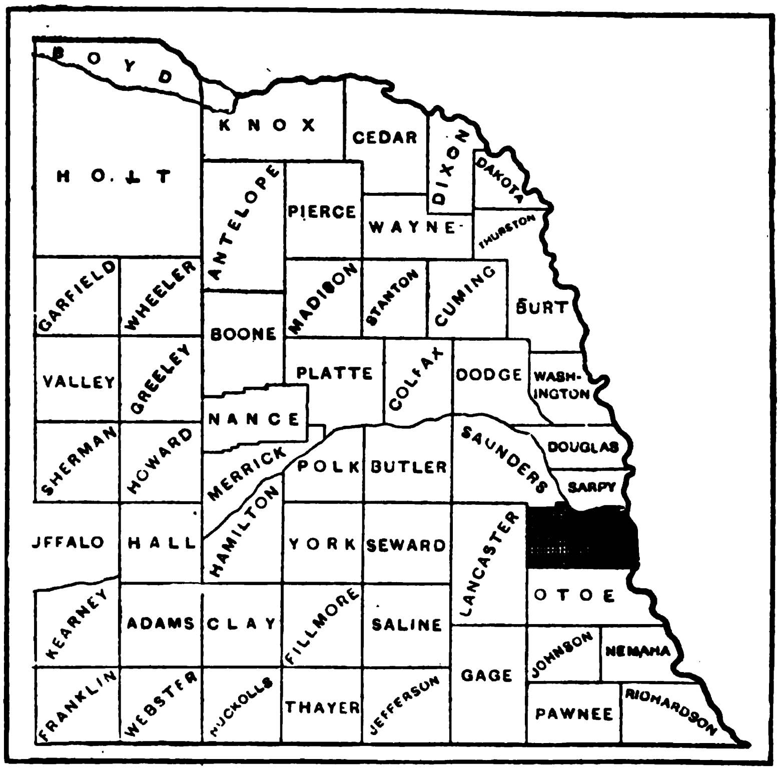


FIGURE 1—Map of eastern Nebraska, showing by shaded lines the area covered by this investigation.

HISTORICAL.

Owing to its Missouri river frontage, Cass county was explored by travelers at an early date. Most of these men were not investigators, but adventurers, seeking excitement or wealth; such men leave little record of their observations, hence our region was known to white men several centuries before even the broadest surface conditions and the hydrography were written about.

One of the first authentic accounts of the geology of the region is in the record of the Lewis and Clark expedition. To quote from the notes of Capt. Meriweather Clark of July 20, 1804 (Lewis and Clark's Travels, Vol. 1) "We passed at about three miles distant a small willow island to the north and a creek called in French L'eau qui pleure or Weeping Water and emptying itself just above a cliff of brown clay." Of this day he further said, "The party who walked on the shore today found the plains to the south rich, but much parched with frequent fires, and no timber, except scattered trees about the sources of the runs, which are numerous and fine".

Sat. July 21, "We passed a willow island on the south near highlands covered with timber at the bank and formed of limestone with cemented shells". This is probably the first account of the general topography and of the limestone exposures in Cass county.

More than sixty years later in 1867, Dr. F. V. Hayden, accompanied by Dr. White of Iowa began those investigations (Report of the Commissioner of the General Land Office, 1867), the reports of which are now classics in the study of this region. In writing from Nebraska City, July 1, 1867, to the Commissioner of the General Land Office he treats quite extensively of his observations about Plattsmouth, Weeping Water and intermediate points. (See Hayden U. S. Geol. Survey of Nebr.) In this final report published in 1871 (Hayden U. S. Geol. Survey of Nebr., page 13) he devotes some space exclusively to Cass county.

A few years later Prof. Samuel Aughey published his report of the state. This region is included in a general way.

The pioneer work having been done, a host of detail workers followed, many of whom are still making investigations. Among the most noted of these are Prof. Barbour (See Vol. 1, Nebr. State Geol. Survey, and various reports of the State Geologist), of the State University, who has studied stratigraphy, fossils. and glacial geology, Mr. N. H. Darton of the U. S. Geol. Survey, Dr. G. E. Condra (See Part 1, Vol. 2, Geol. Survey of Nebr.) of the Univ. of Nebr. who has collected Bryozoa in the entire southeastern part of the state, Mr. C. A. Fisher of the U. S. Geol. Survey, who has studied the Upper Coal measures, and others who have done much work.

Thus in a general way Cass county is known conjointly with other counties of eastern Nebraska, but not individually.

PHYSIOGRAPHY.

Position and Extent.

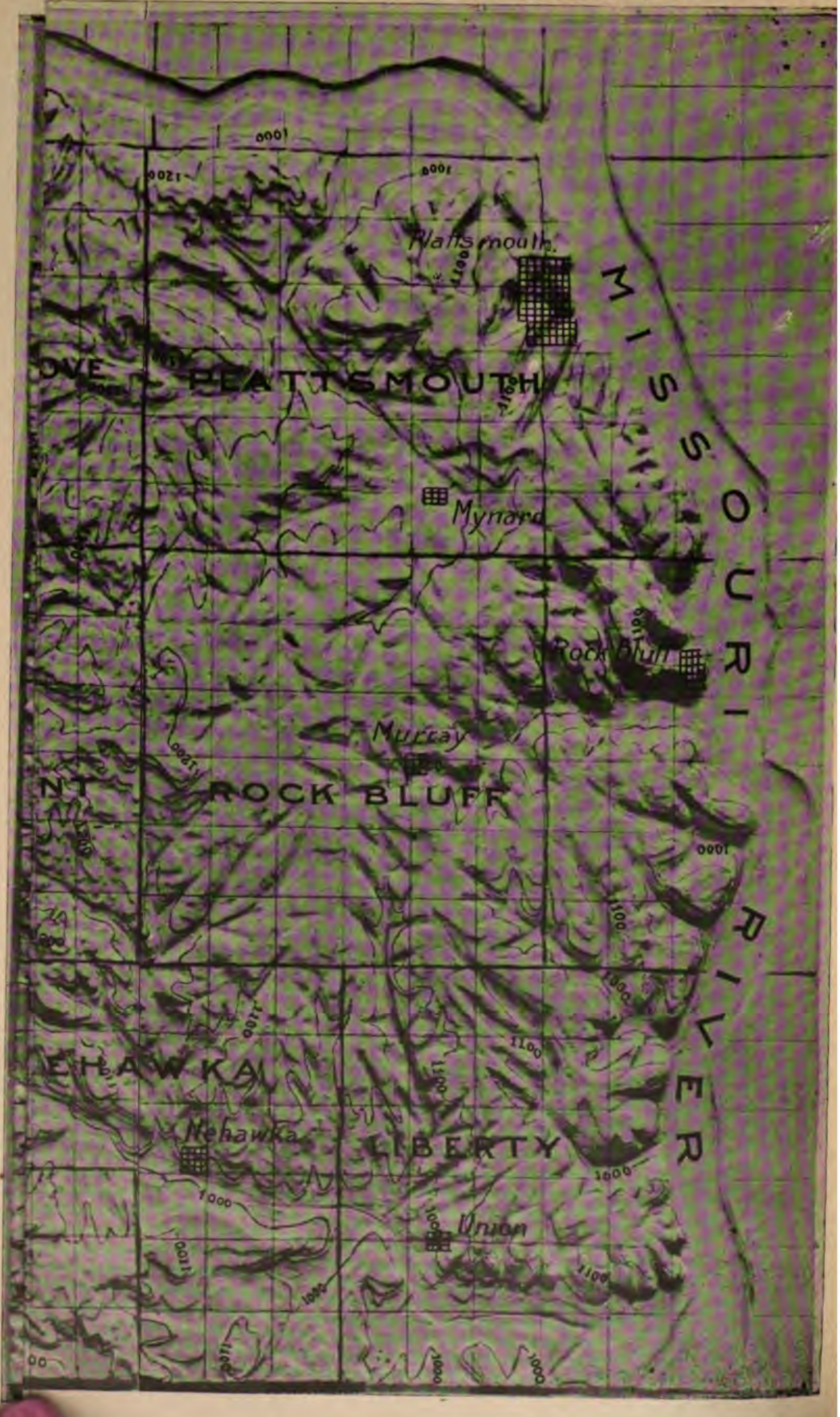
Cass is one of the tier of counties bordering the Missouri River. It lies in the southern angle formed by the junction of the Platte River with the Missouri: thus it has a river to the north and east. Otoe and Lancaster counties are on the south and west respectively, and Saunders county bounds nine miles of the northwest corner. Sarpy county is north across the Platte River. Its general geographic position is a little southeast of the center of the United States. It is directly west of New York City, directly south of Omaha. In form Cass county is an irregular rectangle. If a portion of the southwest corner were removed instead of the northwest corner, as it is now, this county would bear a close resemblance to the form of Nebraska.

Its greatest extent is from east to west, a distance of 33 miles, and the range from north to south is 19 miles. The area of the county comprises approximately 53.7 square miles.

TOPOGRAPHY.

Reference to the accompanying relief map will give an adequate idea of the general topography and drainage conditions. This map is constructed from the government topographic sheets, only preliminary copies of which were available at the time of our survey. The sheets cover all of the county except the precincts Rock Bluff, Liberty and part of Nehawka. In order to finish the topographic map of the unsurveyed portions it became necessary for the writer to make a hasty survey late in the season with insufficient equipment, hence this portion of the work is only approximated. It is deemed best, however, to publish the work in this incomplete condition rather than to delay the entire map until such time as an accurate topographical survey can be made.

Cass county is a well dissected portion of originally level prairie plain, rising from an elevation of 934 feet above sea level at the extreme southeastern corner to a little over 1360 feet in T. 10, R. 9 E. Sec. 20, just northwest of the town of Eagle. These extremes in altitude fail to give us an adequate idea of the general regular slope to the east. The walls of the bluffs along the Missouri River, which rise abruptly to a height of 200 ft., actually mark the edge of the plain which gradually rises from an altitude of 1100 ft. to approximately 1300 ft. near the western border of the county, giving an increased elevation of 200 ft. from east to west, or an average slope of a little more than six ft. per mile. Erosion conditions are so varied that a fair average estimate from north to south is quite impossible. The contours, the lines joining points of equal elevation above the sea level shown by the shaded lines in the map, may be used as a basis for any given region. In the western part of the county the general slope is northwest to Salt Creek. In the center it is from either side to the Weeping Water Creek. In the eastern end the elevation decreases from north to south. The average altitude for the entire county is above 1200 feet. It is meant by this that if the hills were removed to fill the valleys and a level plain were formed, that plain would be more than 1200 ft. above the sea level.


Plattsmouth
PLATTSMOUTH
MISSOURI RIVER
Mynard
Rock Bluff
Murray
ROCK BLUFF
EHAWKA
Nehawka
LIBERTY
Union
1000
1100
1200

NATURAL DIVISIONS.

A number of distinct and characteristic topographic divisions caused by stream erosion during long periods of time are next to be considered.

Platte River Region.

The bluffs along the Platte River rise abruptly, then gradually give way towards the rolling interior, hence in the northern portion of the county near the river, we find a very rugged bluff region from one-half to two miles wide. This region gradually merges to the south into a more rolling land a few miles wide, extending across the country east and west. This latter region is not a level plain; it presents an appearance varying from undulating to rugged, and the streams are actively eroding. Considerable damage is done to crops at times of excessive rains. The interior is rolling, due to the erosion of the many tributaries of the streams. The "wash" here causes little inconvenience to farmers.

Missouri River Region.

The Missouri River is bordered by prominent bluffs, which, though more prominent, in most respects resemble those of the Platte. This region presents the roughest topography found in the county. The streams are short and swift, and only a few discharge throughout the year. Except for a few narrow valleys this region is best adapted to forest trees and similar perennial plants, which aid in preventing the removal of the scanty soil already formed. Back of these bluffs is a region still rugged, with streams in deep narrow gorges, but with the elevations more rounded than the bluffs near the river. Here farm crops thrive well, but much difficulty is experienced from ground wash.

Weeping Water Creek Region.

Weeping Water Creek furnishes a physiographic region peculiar to itself. From its source in the rolling fields of its western tributaries to its mouth this stream gradually changes character.

The rolling outline near its source yields to a more bluffy condition near its central part; this in turn gives way to a more open character in its lower course. The bluffs are especially steep from a point two miles west of Weeping Water to Nehawka; southeast of Weeping Water, and southwest of Nehawka are rugged regions. In all of these sections just noted the limestones crop out near the top of the bluffs, thus protecting the beds below. This produces long slopes composed of fragments of limestone, clay, and soil, and more or less steep, according to the nature of the beds above. These hillsides are valuable only for grazing. Especially picturesque are the large blocks of limestone near the summit of the bluffs above Weeping Water. These massive blocks freed at their jointing planes and undermined by erosion are slowly yielding to the disintegrating action of the weather, and at the same time slowly descending the slopes towards the valley.. Few blocks reach the bottom without entire disintegration.

The Southwestern Portion.

The extreme southwestern portion of the county is quite hilly. The excessive erosion here is probably due to the abundance of sand and gravel associated with the easily eroded subsoil, called Loess. So abundant is the gravel that in places it closely approaches Drift.

Bottom Lands.

There are a few marked alluvial plains. The one most extensive and most characteristic of this type of formation is the flood plain of Salt Creek. This flanks the creek on either side, varying from a few rods to one mile and a half in width. In a few places the bottom lands are the most fertile in the county.

The Platte River valley exhibits a few limited flood plain areas. These occur where streams from the interior discharge into the river. These bottom lands are sandy, slope well, and exhibit fairly good drainage. Near the river margin of these is a border of sand dunes formed by river sand blowing up in low narrow ridges. The railway stations of Cedar Creek, Cullom and Oreapolis are located on these dunes.

Weeping Water Creek presents only narrow flood plains of limited extent. In the last few miles of its course in this county this creek flows through the most extensive flood plain of its entire length.

Benches or Terraces.

A few marked terraces appear along the Platte. A characteristic terrace is within the limits of the town of Louisville. In the eastern part of the town the Missouri Pacific Railway cuts through this terrace. While in the western part this bench or second bottom, as it is called, rises twenty feet above the flood plain. A number of houses located upon it overlook the bottom below, upon which the Burlington & Missouri River Railroad station is located. This probably marks the former level of the Platte River. Much higher terraces are noted farther west along the Platte, but none are distinct in Cass County.

Drainage.

The drainage is well matured. There is no portion of the original deposit from which the surface water is not led immediately into the streams and away from the land. The tributary streams are small but swift. So nearly perfect is the drainage that in times of excessive rains the water runs off at once into the streams, congesting them to such an extent, that within a few hours they are converted into raging torrents, flooding the narrow valleys, destroying fences and often bridges in their courses, but a few hours later again subsiding. Erosion is still active. At no time in the permanent streams is the water free from sediment.

The entire drainage belongs to the Missouri System. It reaches this river by several courses. (1) Direct; (2) The Platte; (3) Salt Creek; (4) Weeping Water Creek; (5) The Little Nemaha. The several systems are discussed below in the order just named.

(1) The drainage into the Missouri direct is through a few short precipitous streams, of which the creek discharging just below Rock Bluff is the chief. Only a few of the streams are perennial. One of the most notable drainage systems is within the city limits of Plattsmouth. Here several streams with short, steep courses, and bordered by abrupt slopes, converge into one trunk.

Thus the water from several square miles is precipitated into one channel; hence the disastrous floods which periodically occur. It is impracticable to obviate the conditions, and expensive to even alleviate them.

(2) The Platte River receives approximately 30% of the water which falls within the county. It reaches the river through a number of streams, of which Four Mile Creek and Cedar Creek are the principal ones.

(3) Salt Creek drains the northwest corner. Six miles of its lower course is through Cass County. The slope is gradual, and the tributary streams flow slowly. The broad alluvial valley of Salt Creek is the only portion of the county not perfecty drained.

(4) Weeping Water Creek with its tributaries is the chief drainage system. It receives water from 40% of the region. Taking its source near the west line of the county, it traverses the south central region, finally passing into Otoe just before the Missouri is reached. In the upper part of the course the stream cuts into the Loess plains. Just east of Elmwood it touches the top of the Upper Coal Measures. At Wabash it cuts twenty feet into these beds. Eastward the valley depth is increased, until at Weeping Water the stream flows through a gorge 125 feet below the upper layers of the limestone. A similar grade continues to the mouth.

(5) Some of the tributaries of the Little Nemaha have their source in the southwest corner. These are small, swift streams actively cutting away the Loess, but draining a small area.

These five systems completely drain the county, and give to it its varied alluvial plains, bluffs, and rolling prairies.

STRATIGRAPHY.

The citizens of Cass County are generally so well informed about the order of beds in the region that the very subject which to others may seem dry and technical is interesting and of practical utility to them.

Stratigraphy is concerned with the order and arrangement ot beds, what they contain, and to what uses they may be advantageously put. All readily recognize the various kinds of stone and understand that they exist in great beds or layers extending over wide areas. It remains to us then only to put this information in definite form and explain the general relations.

Those who are familiar with the digging of wells know that after the soil is removed in most places yellow clay is found, then quite commonly a bed of gravel, if the well is of sufficient depth, and beneath this limestone occurs. This is not universally true. In the north and northwest a red sandstone lies between the gravel beds and the limestone.

These are the same divisions of which the geologists take note. Below is given a table showing the general relation as he recognizes them.

SYSTEM	SERIES	GROUP	FORMATION
	Quarternary or	Post-glacial	Alluvium
Cenozoic	Pleistocene	Glacial	Kansan
Mesozoic	Cretaceous	Dakota	
Paleozoic	Coal Measures	Upper Carboniferous	Missourian

We mean by this that the lowest rocks we find are the limestones known as the Upper Carboniferous; just above these and next in age are the red sandstones, sometimes containing leaves (called Dakota of Cretacous age); then we find a layer of gravel (glacial drift); and above this the buff colored clay, so common, which the Germans have named Loess; finally the black soil covering the surface and especially thick where it has washed into the valleys; this we designate the alluvium. Thus we pass from the rocks which were formed ages ago, to their active destruction and rebuilding into new rocks and soils at the present time. Such is the range of geologic history as told us in Cass County..

DESCRIPTION OF FORMATIONS.

The Upper Coal Measures.

The name which has been given to this general group of rocks would lead us to expect that they contain coal. This is true in other parts of the series, but our rocks are almost destitute of this highly important economic product. According to the typical section taken between Kansas City and Omaha, these beds of limestones and clays are assigned to the Plattsmouth limestones and Platte shales, the former in the aggregate approximating 30 feet, the latter 100 feet*.

This, however, is the sum of the various beds we are able to see, or their aggregate if placed one bed above the other. By boring at various places in the state we find that below these beds there is still a very great succession of others. It is probable the total Coal Measure beds are 1200 ft. thick. Of what lies beneath these we are not certain. Above them are the several deposits of which we will treat later, and which are all included under the two names Cretaceous and Pleistocene. These beds extend under the entire county. It would be impossible to sink a well anywhere to any great depth without coming in contact with the limestone.

The rocks of this series consist of limestones, clays, shale, and a small amount of sandstone in great horizontal beds. These beds are exposed in extensive sections at a number of places in the county. The region of most abundant exposure along Weeping Water Creek is about Nehawka and the town of Weeping Water with its adjacent territory. Here the rocks, clays, and shales are abundant and varied. From Rock Bluff to Plattsmouth the exposure is almost continuous. At the former place occurs one of the most famous sections in this part of the United States*. Dr Hayden visited it almost a half century ago. and made a section of the exposure. Since that time many prominent geologists have visited the place and have made it a basis of correlation. Along the Platte River excellent exposures occur west of Oreapolis, and

*Chas. R. Keys, American Geologist, Vol. 21,1898, p. 309.

east of Cullom around the Creek, where the quarries of Atwood & Company are operated, at Louisville, where occur the old Stout quarries, and at places along the river between Louisville and the mouth of Salt Creek.

The lithological structure of the limestones is extremely varied. Ledges twelve feet thick are found to be massive, very hard, highly crystalline, and composed chiefly of the carbonate of lime. In a few instances a much harder crystalline blue limestone is noted. Thinner crystalline beds with distinct joint planes produce good rubble.

Many of the beds are of loose texture and are badly disintegrated. It is from these beds that riprap is produced. In exposed places the softer beds have weathered to a calcareous clay.

Fossils are generally quite abundant in the various strata, and render aid in correlating the beds.

Carboniferous Clay.

The clays are numerous and extensive. Many of the beds are persistent for long distances, while others are limited to local areas. All the ferruginous plastic clays carry a marked percent of carbonate of lime, not sufficient however to render them objectionable for general clay work. Perhaps the most persistent bed is the red clay, shown in sections at Ashland. Saunders Co., and in the South Bend, Louisville, and Cedar Creek sections, numbered I, II, and IV. Generally these clays are so concealed by beds of limestone that they cannot be profitably worked for commercial purposes. The shale beds are carbonaceous and of local extent. They have been taken to indicate the occurrence of coal, which is a mistaken idea.

Sandstones have limited horizontal distribution and grade into sandy clays.

Flint nodules frequently appear in the limestones. In some beds these are sufficiently persistent to form a basis of correlation. The greater part of the flint has the appearance of being concurrent with the limestone. The flint in some of the more massive beds, however, seems to have filtered into cavities. The mottled appearance of some of the flint is due to the presence of small particles of opal.

A clearer conception of the various coal measure beds, the nature,

of each, the fossil content, and their general relation to the whole system, may be obtained from Figures 23—30.

A comparison of sections I, III and IV show beds 3, 3, and 2 of the respective sections to be similar; the same is especially true of 7, 4 and 6 of the same respective sections. Bed 13 of Sec. II fails to show either of the particular beds mentioned above. The general rise of the beds to the east probably places them above this bed. The same beds were noted low in the hills at Ashland. A lower bed noted in Stout's quarry at Louisville corresponds to number 5 of Section V.

In this correlation a bed of red hematitic clay is taken as a basis. This bed is persistent with similar beds of limestone above and below. A crystalline limestone containing Fusulina secalica and distinctly marked by a layer of flint nodules near the center, is another persistent horizon. This appears as Sec. I, 7; III, 5; and IV, 6. Dr. G. E. Condra reports the same bed as persistent on the north side of the Platte River.

It will thus be seen that the beds are very nearly horizontal, with a slight dip to the west. The slight structural undulations noted in places should not be confused with the general trend of the strata.

Similar conditions exist along the Weeping Water with perhaps a greater westward dip indicated east of the central part of the county.

An attempt to correlate the beds from north to south presents a much greater difficulty. The beds seem to dip to the south. This is most evident between the mouth of the Platte River and Plattsmouth, and is also notable between that place and Rock Bluff. With this probable dip and the increase in altitude, it is likely the beds shown in Secs. VI and VIII along Weeping Water Creek are in higher levels than those shown along the Platte. No distinct folds are noted.

Dakota Formation.

The red or brown sandstones found above the limestone in some localities is called the Dakota, because it occurs extensively at Dakota City, Nebraska. A casual glance at this rusty ferruginous (iron) sandstone convinces the most casual observer of its wide difference from the limestones. Its texture, its massive character,

its separation into beds by only indistinct lines, all indicate not only a difference in the stone itself, but also a wide difference in its mode of origin. The Dakota sandstones lie unconformably upon the Coal Measure limestone beneath. The maximum thickness of the Dakota probably nowhere exceeds 100 ft. It is found only in the northern and western portions of the county, where it outcrops near Louisville, west of South Bend and in small areas about Greenwood. It is more common in wells in these regions.

This formation presents three phases, (1) beds of sandstone. (2) a few immense deposits of gravel and sand, and (3) beds of clay.

Sandstones.

The rust colored sandstone is found only in the north and northwestern portion of the county, where it is commonly encountered in wells. This consists of small particles of quartz-sand, similar to the sand now so abundant in the Platte River. This sand is coated over and cemented together by one of the iron compounds known as limonite (the same compound formed by rusting iron). The percent of the cementing material varies greatly. When a very small amount is present the grains of sand are only loosely held together, in which case the deposit is a loose sand or a very soft sandstone. In this region it most commonly occurs as a loose sandstone. If the cementing material is in larger quantities the stone becomes very hard.

Because this cementing material (the iron) is soluble to some extent in ordinary water, it is washed away by rains, leaving the grains of sand loose. This is the reason the sandstones are of so little value for exterior work, and the reason that where they are used they must be soon replaced by more durable material. These sandstones resist erosion in a peculiar way, yielding typical rounded bluffs. The exposures here are better examples than the type bluffs at Dakota City.

The leaves figured here are not from Cass County. Fragments are found and complete specimens may be expected to appear with more complete search. To produce such leaves there must have been, at the time of deposition, fresh water conditions with forest surroundings similar to our own. The walnut, oak, and willow

(See Plate 7)

are dropping their leaves each year, and these leaves are being buried in modern sand and silt, just as in ancient times. Pieces of logs and bark were noted near Louisville and Cedar Creek. Cross bedding is marked throughout the region. The best opportunity to view this is along the Platte River west of South Bend. Here both bedding and cross bedding are distinct. In this region the cross bedding dips to the west with certain exceptions.

Dakota Gravel.

The gravel formations occurring in this and other counties will be made the subject of a special paper by another member of the Survey. These have not been sufficiently studied at this time to make a definite statement regarding their origin. It has been suggested that they mark the course of an ancient river. The deposits belong to the Dakota period of the Cretaceous. They are derived mostly from igneous rocks far to the north or northeast. A portion of the material comes from older sedimentary rocks. Species of coral are associated with the gravel. Two varieties of Favosites and one of a Rugose coral have been identified. A study of the fossils will certainly develop the source of the gravel. The waterworn conditions indicate the source to be at no small distance. In size, the particles vary from grains of fine sand to coarse, irreguar pieces as large as a walnut, the average is from the size of a pea to a large hickory nut. All are rounded and waterworn. The grains are coated with oxide of iron, which also acts as a loose cementing material. Quartz pebbles predominate, but feldspar is common.

Dakota Clay.

Excellent beds of plastic clay occur in this Dakota formation. These are entirely unstratified, and vary in color yellow, red. gray and mottled predominating, with apparent absence of fossils. They are very irregular local deposits. An excellent clay for all grades of brick work is afforded. Their origin, mode of deposition, and source is undetermined.

The water-bearing properties of the various Dakota beds are treated in another portion of this report. The economic import-

FIGURE 2—Exposure of carboniferous limestone in the old Reed quarry, Weeping Water, Nebr., showing striæ running south 29° west.

ance of the gravel and clay should not fail to attract attention. are noted in Anderson township of Mills County, Iowa*.

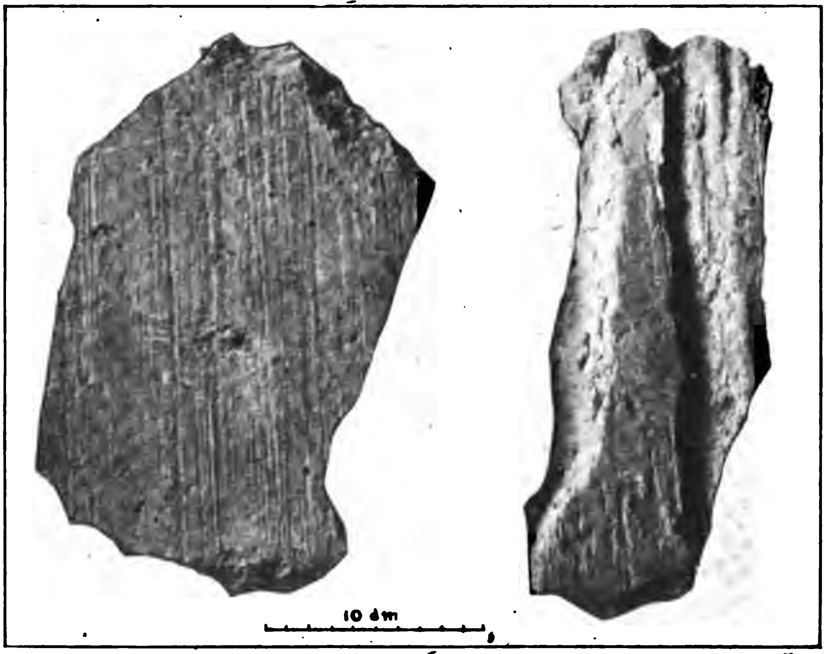
Cass County was on the edge of the former great Dakota sea. At this time the northern and western portions were submerged, while the eastern and southern were elevated. In the western part of the county the shore line turned quite abruptly south. To the other side of us its direction is a little northeast. Exposures are noted in Anderson township of Mills County, Iowa.

This sea may have extended over the entire county and subsequently been eroded. Such does not seem to have been the case. Only a few Dakota fragments are mingled with the drift. In no case has an old Dakota depression been found in the southern part of the county, which must certainly have occurred, if the sandstone ever covered the entire surface.

Pleistocene.

After the recession of the sea in which the red sandstone, gravel and clays were deposited, the great glacier in its turn covered the surface. The glacial deposits then lie above the sandstone and limestone and are covered above by black soil. Probably the maximum deposit does not exceed 200 ft. The average thickness is below 100 ft. Our ice sheet moved as a mass southward; probably only once did the glacier cover this territory. Here in its passage it had a direction about south 29 degrees west. In 1898, the writer first noted the glacial scratches on the top of a ledge in the eastern part of the Old Reed Quarry at Weeping Water. At that time specimens showing striations were secured for the University of Nebraska at Lincoln, where they were figured and described in a pamphlet entitled "Glacial Grooves and Striae in Southeastern Nebraska," by E. H. Barbour. The ledge is one of massive limestone, exposed 300 feet horizontally. The exposure was made for the purpose of removing the stone for crushing. It is smoothed and scratched over the entire surface, but more noticeably so near the west end of the exposure. Further to the west a Sioux quartzite pebble was noted in a groove where the ice ceased its work. Slight cross striations are common. These striations are still open to view, the work of quarrying having ceased before the ledges were removed. This

*J. A. Adden, Iowa Geological Report, Vol. XIII.



(3) (4)

Figures 3 and 4—Sections of limestone showing glacial striæ. These specimens were secured at the old Reed quarry, Weeping Water, Nebr.

is the most positive and distinct evidence of the movement of the ice sheet in this county. The red, pink, and drab boulders found in every section add another important link to our chain of evidence of the movement of the glacier. Prior to the invasion of the ice sheet in this county these Sioux quartzite boulders were in their native positions at Sioux Falls, South Dakota, where immense ledges are now to be found. Besides these large boulders on the surface, the ice carried much small gravel which, like the former, it left in its retreat. These were spread as a sheet, varying in thickness from a few inches to a foot or more. This sheet is more noticeable above the beds of limestone, but also occurs over the red sandstone formations. Where the soil and Loess have washed away, this gravel appears very thick. On some of the hills north-east of Eagle the surface is strewn with it. Drift is the name applied to this sheet of gravel. Though this deposit is almost entirely covered, people in general are familiar with it, for in this they seek the "sheet water." Boulders frequently occur along the Platte River and Weeping Water Creek. These often weigh many tons. One two miles west of Nehawka is oval in outline. 10 ft. long, 6 ft. wide and 2½ ft. extending above ground. The amount buried can only be estimated.

Loess.

The great surface deposit in the county is the Loess, from a German word which means to loosen; so named because of its peculiarity of breaking or jointing into columns or sections. In places the Loess is buff above and red below. In some sections irregular deposits of quite red Loess are noted. It is familiar to many as joint clay, the common yellow clay of cellars, wells, and railroad cuts. A most typical and extensive exposure is at Plattsmouth where the B. & M. cuts through the bluff just before approaching the railroad bridge over the Missouri.

Originally this deposit must have covered the entire surface to quite an even plain, thickest near the Missouri River and gradually thinning to the west.

This condition exists at present, although in places much Loess has been removed by erosion. Near the Missouri the distance between the highest and lowest points of these beds

exceeds 200 feet. The original deposit probably did not reach this depth. Loess is prone to slip and in this way excessive thickness has resulted. At the western border of the county the Loess veneer becomes so thin that it averages scarcely 50 feet; where erosion has proceeded along the streams it is thin or wanting.

The general nature of the Loess is a fine sand mixed with a little clay containing some iron, which is its coloring matter. The Loess readily yields to erosion. In this way many short, sharp ravines are formed. Canyon-like gorges occur in steep ravines which end in a precipitous wall, where, at times of excessive rainfall, the water pours over some obstruction to its course.

Whether the Loess was deposited by wind or water is not known. In certain parts of the world it is quite well established that this, or at least a similar formation, is a wind-blown deposit. In such places evidence of stratification, a condition which would exist in an aqueous deposit, is not known. In our region, however, though in most places no stratification is evident. such localities do exist.

This subject is one upon which geologists in general fail to agree. The general evidence seems to point to an aeolian deposit; in our region, however, water seems to have played a part. No single region can be taken as furnishing conclusive evidence to either view. The bluffs along the rivers and creeks are due to the occurence of Loess. Because of its ready erosion forming deep slopes, it is sometimes called the bluff deposit. The bluffs rise precipitously from the water or valley level, and, after reaching a summit, gradually slope to the more rolling interior. Timber partly covers the slopes and prevents the excessive erosion which would otherwise take place. The Missouri River bluffs when seen from across the stream, afford a most picturesque view, and afford an excellent conception of the rapid erosion which is taking place. These bluffs were originally a portion of a level plain. Since then rains have started streams which in their rapid courses have cut into the Loess, undermining large pieces of it. These pieces on breaking off gave rise to walls and bluffs more or less precipitous. This process of deepening, side cutting, and washing of the hillsides has continued until great valleys now ex-

ist between the bluffs, which themselves are being rapidly carried away.

Alluvium.

At this time a deposit is being formed and shifted about along the streams. This is called alluvium and is composed of material washed from the hillsides. The vegetable matter it contains renders it very fertile. The most notable deposit of this is the broad valley of Salt Creek. During the excessive rains in the spring time the creeks are unable to carry their load as they enter the valleys where the grade is not so steep, so layer after layer is deposited as the years go by and a stratified flood plain or bottom is built up. The shifting sand along the Platte and the changing bars in its course must be assigned to the same general formation. The sand which now clogs the Platte River has its original source in the mountains to the west and is brought in, worked over, and assorted by the constant action of the river. When the water is low this sand dries and is blown into low ridges, seldom exceeding 20 ft. in height, along the shore. These ridges are known as sand dunes. Their slope and nature depends entirely upon the nature of the valley and the obstructions met by the wind. In places they are long, low ridges. A clump of trees sometimes presents an obstruction, and here a conical hill is formed. The best sand dunes occur along the Platte near Cedar Creek and Oreapolis. At the latter place the characteristic ripple marks produced by the wind were noted. No sand dunes occur along the Missouri. Where available, the alluvium furnishes the most productive soil. The flood plains often contain the remains of animals buried a considerable distance beneath the surface. Bones of the horse, deer and antelope are found.

MINERAL RESOURCES.

Cass is distinctly an agricultural county; the rich. well watered fields are productive of wealth far greater than can ever be expected from other economic resources. Yet in point of variety and amount of natural products no county in the state is equal to this one. True a comparison with an equal area in mountainous states is not favorable to us, but the isolation of a prairie country greatly enhances the commercial value of our mineral products.

Coal.

More space perhaps will be devoted to the consideration of this highly important economic product than the amount produced merits. The indications are not such as to lead us to prospecting, though all certainly wish success for such enterprises, but in the minds of many there is a deep conviction that this highly important economic product lies hidden beneath our feet, and only awaits capital and energy to bring it to light.

However much desired, it is probable Nature has not concealed paying amounts of coal in Cass County. It is not our desire to discourage any one, but to present the facts as our survey finds them, hoping that any who prospect may do so with greater information as to the chances of success or failure.

Scientists versed in these matters have given us notes worthy of our consideration. After discussing the conditions and indications Dr. F. V. Hayden, then at the head of the Government Geological Survey, who had visited Nebraska to study the geology with coal conditions especially in view, says in his report of 1872 — 31 years ago, "In regard to finding workable beds of coal within accessible depths in Eastern Nebraska by deep borings, I would remark in conclusion, that, though not prepared to discourage entirely all hope of success, it is proper to state that all the known facts are unfavorable, not only on account of the great thickness of the nearly barren series, but because it is by no means certain that we should strike the productive measures here, even* after going entirely through the upper, nearly barren, series, since

*United States Geological Survey of Nebraska, p. 189.

the lower beds may thin out in this direction." In speaking of the boring at Omaha, he says, "It should be continued to a depth of 1000 to 2000 ft. or more." Thirty years of prospecting at various places have proved this conclusion correct*.

In 1880 Samuel Aughey said, "The question rises whether there is any probability of any valuable beds being found anywhere in the state. Truth compels the admission that such a result is uncertain and even doubtful."**

Prof. E. H. Barbour, after close investigation says, "It is never an agreeable task to inform people that there is little prospect of ever finding coal in their state, but such is the fact in Nebraska."

Besides our own geologists agreeing on this, those of both Iowa and Missouri are of the same opinion***. Only thin seams of bituminous and lignitic coal are known in the state. The reader is warned not to consider carbonaceous shale as an indication of coal beds appearing lower. The carboniferous strata which underlie this part of Nebraska are deep sea deposits, while it is a well established fact that coal is the remains of plants which grew in and around fresh water, and which were deposited in situ. This being the case, it will be readily understood why coal in commercial quantities is deposited here.

So many failures are recorded that extended warning is not out of place. Every few years some experimenter creates a boom which must end in disaster to those who furnish financial support. An example of such experiment is the one, still fresh in the minds of many, which was tried at Louisville during the summer of 1903. It is and has been the concordant opinion of geologists that these costly experments will always result in failure. Unfortunately no record of deep borings is obtainable upon which to found data by direct observation, but all evidence brings us to an unfavorable conclusion regarding the finding of coal within the limits of Cass County. Below is given an analysis of some coal from Cass County by Prof. H. H. Nicholson, No. 1934.

Moisture	13.23
Volatile matter	44.56
Fixed carbon	32.04
Ash	10.21
	100.04

*Physical Geography and Geology of Nebraska.
**State Geological Survey of Nebraska, Vol. 1.
***See Reports of Iowa by White, and Reports of Missouri by Broadhead.

For comparison below is given an analysis of bituminous coal from Pennsylvania.

Moisture	1.3
Volatile matter	20.87
Fixed carbon	67.20
Ash	8.80
Sulphur	1.83
	100.00

Petroleum and Gas.

Some have supposed the irridescent scum found on stagnant water along streams necessarily indicated oil or natural gas, but such is a mistaken conclusion. The material is neither oil nor of oil origin. It is found to be either from decaying vegetable matter, or one of the higher oxides of iron. The dip of the strata would long ago have permitted the escape of petroleum and gas had it ever been enclosed below.

Gold.

The sands of the Platte River and the glacial drift contain a small amount of gold. Many have supposed the yellow sparkling flakes in the sand to be gold. These are probably flakes of mica, and can be distinguished from gold by placing them on a flatiron and beating them with a hammer. Gold will flatten. mica will not. Iron pyrite may be distinguished from gold by roasting, in which case pyrite turns brown, while gold does not. These misconceptions have led to excitement at various times, but no placers, properly so called, have been found. This precious material has been so widely disseminated by its long journey from its source in the Rocky Mountains, that no considerable quantity is deposited near the mouth of the Platte River. Below are given the results of assays of sand taken from the bed of the Platte River at Cedar Creek, made by Mr. W. R. Calvert of the State University.

Four assay ton sample used requiring 8 assay tons PbO. The litharge carrying 2.2 milligrams of silver per assay ton. Bead obtained 1.76. All from the litharge.

No. 5. Four assay ton sample used. The bead weighs 1.97

FIGURE 5—Old Methodist church, built of native limestone, at Weeping Water, Nebr. Streaked with iron rust, due to the weathering of pyrite nodules.

milligrams giving a possible .21 milligrams from the sample, or .0525 milligram per assay ton. This bead inquarted and treated with nitric acid showed no trace of gold.

University No. 3. Four assay ton sample used, requiring S assay tons PbO. The letharge carrying 2.21 milligrams of silver for assay ton. Bead obtained 1.76 milligrams. All from the PbO.

Iron.

Though the red sandstone contains a considerable percentage of iron, it is not in sufficient quantities to be considered from an economic standpoint. The irregular hardened accumulations of sand and iron are called concretions. These are formed by water filtering through the sand and depositing certain salts about some central nucleus. Concretions are often hollow.

Iron in the form of pyrite or fool's gold occurs in clays and shales and sparingly in the limestone of some quarries greatly to the detriment of the rock.

Marcasite.

This is the sulphide of iron so often occurring in sand, clay, shale and limestone. It is much to be regretted that such a deposit is to be found, since on exposure to the atmosphere it exchanges its sulphur for oxygen in the air thus producing the rust streaks so common in many of the buildings constructed of limestone. Limestones containing the shiny gold particles or nodules should be avoided. A most remarkable set of rust streaks was to be observed in the Methodist Church at Weeping Water before its recent reconstruction.

Calcite.

The carbonate of lime is the chief component of most limestones. Often in these limestones cavities are found partly or completely filled with beautiful transparent crystals of pure calcite. They possess no commercial value.

Stone industries.

Cass County produces more stone than any other equal area in Nebraska. The limestone from the Carboniferous beds constitutes nearly the entire amount. To this should be added a small quantity of red sandstone from the Dakota Cretaceous layers.

Many fail to realize the great economic importance of this industry. Not only does it employ a large number of men throughout the year, but in times of panic as was experienced a few years ago, or during idle periods of each year, the small quarries prove a source of revenue of no insignificant amount. It means very much to the man who has only his labor at his disposal.

Several varieties of stone are produced. Rubble is the most general kind. It is used for all purposes in local building and constructional work. Generally a good grade comes from the numerous small quarries. From the larger quarries where the massive ledges are utilized, the stone is passed through breakers and screens and is then sold as crushed stone to be used for concrete in foundations, sidewalks or street pavement, or as ballast on the railroads. The highest grade chemically of limestone is now selected at the quarries and shipped to the various sugar factories in the state as at Norfolk, Ames, Grand Island, and Holdrege, where it is calcinated to lime and used in purifying sugar. Such stone must contain a high percent of carbonate of lime and be quite free from such impurities as clay and flint. So great is the demand for this grade of stone that some difficulty is experienced in furnishing a sufficient amount to supply the market. Quarry operators may well count on this as a ready and growing market for their best grade of stone. The coarse, rough, shaly stone is called riprap from its employment in riprapping the streams when it is used to prevent the water from cutting away the bank. In such work a coarse. rough, cheap material is necessary. The loose stones lying about the surface or the shaly limestones in the quarries are used as riprap. Riprap finds a market in the government river work where attempts are made to straighten the channel of the rivers (our stone is used in the Missouri River), or to prevent the river from cutting away towns or bridges. The method of operation is to weave large mats of willow slips and

weight them in place by means of rocks. This not only prevents erosion, but collects sediments as well. The railroad way of riprapping is simply to throw the stone in the stream where the water is cutting away the road bed. During very rainy seasons sufficient riprap cannot be obtained to supply the demand. This was especially true during the year 1903. At that time when a location convenient to a siding could be found it was profitable to pick the loose stones from the talus slopes and load them on cars to be used in preventing the railroad tracks from being washed away. A small amount of building stone is produced but its quality is such that it fails to find ready sale. It must compete with brick and better, though more expensive stones, brought from other states. It is a fair stone but is greatly excelled by Bedford limestone and Berea sandstone. The relation of the railroads to our stone interests should not fail to attract our notice. These extensive industries owe their existence to the railroads. The stone must be marketed at a distance from the quarries; for this marketing the operators are dependent upon the railroads. Large quarries can exist only where railroads are accessible. Quarries occur only along streams where a sufficient amount of the covering has been removed by erosion to make the stripping easy and where opportunity is afforded to dispose of the refuse.

During early settlement small lime kilns were constructed to produce lime for local use. Since the advent of railroads lime has been produced in a commercial way at Nehawka and Weeping Water, where abandoned kilns still remain. During one season at Weeping Water the product from two kilns amounted to 43,000 barrels. The kilns were simple in construction, being built of native limestone in rectangular form lined with fire brick; near the lower part on either side were openings for fire boxes; beneath an iron door permitted the escape of the lime when completely calcinated. The location at the base of the steep hill permitted the construction of a platform at the top with an approach to the road leading to the quarries. By this means the kilns were charged with limestone from carts drawn by a single horse. Long sheds with stone floors furnished space for the cooling and barreling of the lime. A portion of the shed was used for a cooper shop. Coal and wood from the surrounding region were used as

FIGURE 6—Main ledge, Old Reed quarry at Weeping Water, Nebr.

fuel. This industry is now abandoned. At Nehawka a sheet iron kiln was constructed. The operation was in general similar to that described above. The production of lime is no longer found to be profitable.

Varying quantities of limestone have been in demand at the Omaha and Grant Smelter at Omaha, where the stone was mixed with the ore for a flux to more readily reduce the metals to a fluid state. The great decrease in the activity of this plant has reduced the demand for limestone to a minimum.

Much of the crushed stone now finds a market as concrete and in the manufacture of artificial stone. To form concrete the stone is mixed with cement and sand and is placed in ditches or troughs where it is allowed to harden. The artificial stone is constructed by mixing cement, sand, crushed stone and flint chips, and tamping the mixture in a mould. This hardens the mixture sufficiently so that the sides may be removed from the mould and the block set aside to solidify.

Quarry operations are limited to areas wherein good stone is concealed beneath light stripping. Practically all quarries are forced to confine their operations to entering the bluff a few rods and extending the works along the face of the hill. In only a few cases is sufficient stone obtained to pay for stripping twenty feet thick. It will require many years to exhaust the possibilities of producing stone profitably. This is especially true along Weeping Water Creek where a large number of excellent sites may be developed. Citizens having good quarry prospects should be in no haste to dispose of their land, for it will ever continue to be a marketable product.

The producing area is divided into three regions, one along the Platte, one on the Weeping Water, and a small triangular section between these two, and facing the Missouri. For descriptive purpose the quarries are arranged in two classes. Commercial quarries, or those shipping extensively to various cities throughout the state, and Local Use Quarries, or those producing a small amount for the markets near at hand.

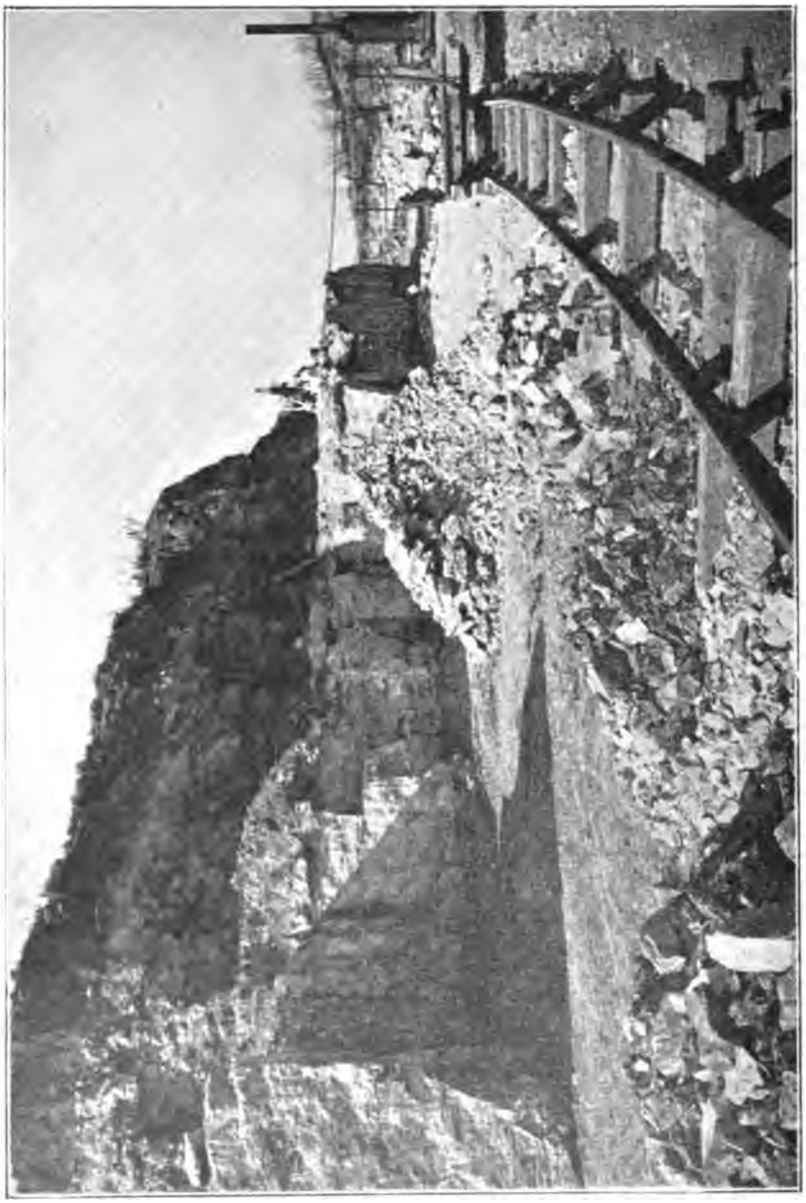


FIGURE 7—General view of the Commercial Land Company's quarry, two miles south of Weeping Water. (*a*) Loess. (*b*) Weathered limestone. (*c*) Marketable limestone, carboniferous.

Commercial Quarries, Weeping Water Region.

Old Reed Quarry.

This is an extensive quarry on the bluffs southeast of Weeping Water and adjacent to the town limits. Though now abandoned it was formerly operated on a very extensive scale. This quarry is open for one-third of a mile along the bluffs. The section given is not compiled but taken near the west end. This quarry has been abandoned for a number of years. The lime kilns are rapidly crumbling and falling to pieces. The crusher and machinery though still in place show evidence of decay. The whole scene is that of an abandoned work. The writer is indebted to Mr. Hart. who was formerly foreman of the lime department, for the following notes. The quarries were opened in 1882. The following year the kilns were in operation. At one time 207 men were employed. The best season 43,000 barrels of lime were produced. No total figures are available for the stone output; however, it was many thousand cars. The maximum for one day was 100 cars. A portion of this quarry can now well be placed in profitable operation.

Commercial Land Company's Quarry. Two miles southeast of Weeping Water, on a point of a bluff, is located one of the most extensive works in this region. This quarry is worked around the bluff 700 feet to the north and 1200 feet to the west, making a total working face of 1900 feet. The size of the opening evinces the fact that this is one of the largest quarries in the middle west. A crusher with a capacity of 60 tons per hour is in use. A revolving screen separates the crushed stone into the various grades. Forty men were employed continuously during the summer of 1903 Carts and trams transport the stone from the face of the quarry to the crusher and cars. One steam drill is in operation. The output of this quarry is crushed stone, rubble. sugarstone and riprap. It is impossible to estimate the total output, or to state its commercial importance to the region. It was opened in 1889, and has been operated almost continuously since. At the present rate of output sufficient stone is available for a number of years.

Swede Quarry. This quarry is located on the north side of the creek, three miles east of the town of Weeping Water. Though now abandoned it was at one time a very extensive producer of

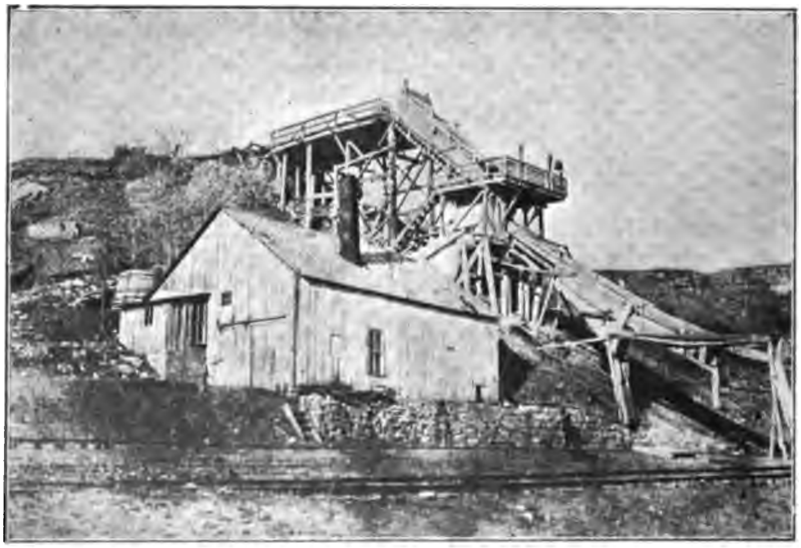


FIGURE 8—Reed's quarry and crusher near Weeping Water, Nebr.

stone. During part of the time when it was operated 180 men were employed. Thousands of cars of crushed and building stone, and riprap have been removed. A thirty foot face is exposed for one-third of a mile along the bluffs. Were the demand for stone sufficient this quarry could be extended and operated with profit.

Van Court's Quarry, Nehawka. This quarry is located on the bluffs south-east of Nehawka. In point of production it is second second in the country. Concrete, rubble, and building stone are produced. Both carts and trams are used to transport the stone from the face of the quarry to the crusher. This quarry is owned and operated by Mr. E. D. Vancourt of Omaha. Mr. Rhodes, foreman of the quarry, furnishes the following data. This quarry was opened in 1889 and has been in continuous operation since that time. Rock has been removed from fifteen acres at this time (summer of 1903). He estimates that 30,000 cars of 30,000 lbs. each, have been shipped. An average of forty men are employed. It is worthy of note that some of the men now at work have seen fifteen years of continuous service in this quarry. Eight acres of stone are still available. A No. 5 crusher, with a capacity of fifteen cars per day, is now in use. A revolving screen is used in sizing the stone. This same firm is now opening a new quarry two and one-half miles west of Nehawka. This is at a site where formerly some prospecting was done and a little riprap taken out for the Missouri Pacific Railway. A sidetrack has been laid to the quarry and development work is proceeding. This when in full operation will be an extensive producer of the various grades of stone.

Platte River Region.

Quarries about Louisville. The quarries about Louisville, though now abandoned, were once so extensively operated that they are deemed worthy of brief notice.

Beginnig a short distance west of Louisville. abandoned openings extend for half a mile along the north face of the bluffs. These openings are neglected and overgrown with trees. Some years ago quarrying was carried on quite extensively. No records of the kind or amount of stone produced are obtainable. Ledges now exposed show material suitable for crushed stone and riprap. Stripping is too heavy to render the working of this region profitable.

FIGURE 9—Crusher and screen of Commercial Land Company's quarry, one and one-half miles south of Weeping Water, Nebr.

Old Stout Quarry. One mile east of Louisville is the Old Stout Quarry. This was from 1880 to 1890 the most extensive stone producer in the state. Thousands of cars of material were shipped. Practically all grades of stone used in construction work were produced from this great quarry. All now presents a typical case of the abandonment of a once extensive enterprise. The large stone house built with the purpose of employing convicts from the State Penitentiary stands on the bluff just back of the works as a land mark to the surrounding country.

Cedar Creek Quarries. Atwood and Company, with offices in Plattsmouth, are the most extensive producers of stone in Nebraska. From their works at Cedar Creek and Cullom more stone has come than from any other quarries in Cass County. No figures are available, but conservative estimates run far into the tens of thousands of cars.

The old works three miles southwest of Cedar Creek are now abandoned. Twenty acres of land have been entirely quarried over. Rubble. crushed stone, sugarstone, and dimension were produced at an average of twenty cars per day. This quarry operated continuously for 15 years. On an average from 40 to 50 men were employed. The stone was a very good grade but stripping became too heavy for profitable operation. At the main office Mr. Atwood was unable to give any data regarding the amount of stone shipped etc.; therefore it is necessary for us to confine our description to a mere outline.

Atwood & Company's New Quarry. During the last season the company has opened a new quarry one and one-half miles southwest of Cedar Creek. The section given of this quarry is typical of the present face only. As work progresses higher ledges now covered by talus will be encountered. The present opening is only 300 feet long, but this can be extended a quarter of a mile. The output will be from 18 to 20 cars per day. The plans anticipate fifteen years of continous operation. Two crushers, Nos. 1 and 3, with revolving screens, elevators, etc., are in use. This quarry is operated upon the most modern methods with a complete drainage system, steam drills, etc. This will be the largest quarry in this part of the state, producing crushed stone, rubble, sugarstone, and riprap. The demand for stone is continuous. The

FIGURE 10—Quarry, men, and a section of the main ledge in Van Court's quarry, Nehawka, Nebr.

Burlington & Missouri River Railroad purchases riprap and ballast. Much crushed stone goes to cities for concrete. Sugarstone goes to Norfolk and other sugar factories.

Cullom Quarries. These quarries have been temporarily abandoned. They were operated periodically for fifteen years. During two years of the fifteen, fifty men were employed. At these quarries stone is taken from ledges near the summit of the bluffs and conveyed by tram cars to the railway tracks below. Gravity is used to propel the cars; a loaded car attached to a cable returns an empty one at the other end of the cable. Sugarstone and riprap are the grades used. It is said to be a very high grade of limestone. In general, these quarries are extensive producers of excellent stone for various uses.

Local Use Quarries. In many portions of this county limestone is exposed in a manner to afford opportunity for small quarries. Those who own such properties generally excavate sufficient stone for farm building purposes or for sale in the immediate neighborhood. Occasionally, if proximity to a railroad permits, a few cars are shipped annually, but not in sufficient quantities to create a definite market. The value of this stone is not in its export worth, but in obviating the necessity of importing stone from long distances. This class of stone, rubble etc., markets for from 10c. to 50c. per perch in the ground, or $1.00 to $1.50, quarried. Stone for constructional purposes in the country is quite generally supplied from this source.

Along the Platte River is an area in which the red sandstone is exposed. This sandstone is used to some extent for foundations. From Hoover's Quarry at Louisville a few cars are shipped each year. This sandstone is quite soft and readily yields to weathering. Such objections are partly compensated for by the ease with which this stone is shaped for its purpose. In cellar walls and similar places where not exposed to weathering, this stone is a very serviceable material.

Below is given a tabulated list of Local Use Quarries, with data as far as obtainable.

FIGURE 11—Crusher, revolving screen, and engine house at the Van Court quarry, Nehawka, Nebraska.

TABULATED LIST OF QUARRIES.

Operator of Quarry	J. C. Jones, Weeping Water	Lewis Weeks, South Bend	H. F. Taylor, Union	Chris Ross Nehawka
Location T	10	12	10	10
R.	11	10	14	13
Sec.	9	15	17	32
	W. E.	S. W.	S. E.	
Is it now operated?	No		Periodically	Periodically
Extent of opening from which stone is taken.	5 rods			
Possible extent of opening	20 rods			30 acres
Thickness of stripping	10 to 20 feet	8 ft.		½ to 2 ft.
Number of ledges used	Two	One	Three	4 ft.
Thickness of each	16 in. & 6 in.	6 to 9 ft.	3, 7 & 14 in.	6, 10, 12 & 18 in.
Kind of stone	Building	Rubble		Rubble
Use of stone	Foundations, etc.	Buildings		Buildings
Local or public sale	Neither	Local sale		Local sale
Total amount quarried	Unknown	10,000 perch		1000 wagon loads
Number of men employed	None	None		

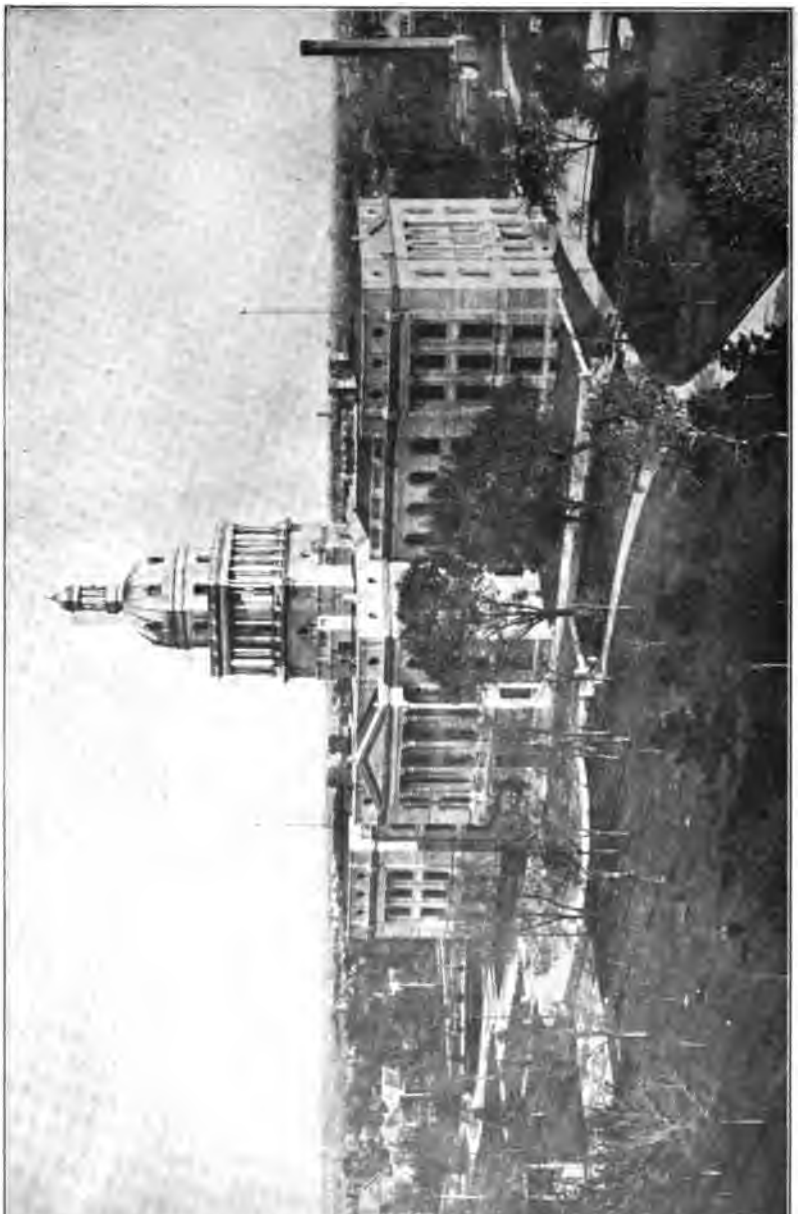


FIGURE 12—State capitol, Lincoln, Nebr., built of native carboniferous limestone, a portion of which came from the old Stout quarry at Louisville, Nebr.

TABULATED LIST OF QUARRIES.

Operator of Quarry	W. A. Royal, Plattsmouth	L. J. Griffith Nehawka	G. S. Upton, Union	J. F. Hoover, Louisville	L. G. Plybon, Nehawka
Location T	11	10	19	12	10
R	14	13	10	11	13
Sec	18	30	13	33	5
	N. E.	S. E.		S. W.	S. W.
Is it now operated?	Yrs.	Yrs.			
Extent of opening from which stone is taken	Half mile	45 rods	100 ft.	20 rods	15 rods drop
Possible extent of opening	¾ mile	85 rods	180 rods	40 rods	45 rods
Thickness of stripping	4 feet	3 feet	156 feet	4 to 8 feet	5 to 6 feet
Number of Ledges used	3	2	8	9	4
Thickness of each	4 ft. 6 in. & 14 in.	14 in. 7 in.	26, 30, 3, 8, 4, 10, 5, 12 in.	12, 12, 10, 10, 6, 6, 5, 5, 5 in.	11, 9, 24 & 7 in.
Kind of stone	Limestone	Limestone	Limestone	Limestone	Limestone
Use of stone	Building, pavement and curbs	Buildings		Buildings	Buildings
Local or public sale	Local sale	Local sale	Local sale	Both	Local sale
Total amount quarried	1500 perch	2500 perch	1500 perch	500 cars	500 perch
Number of men employed	4			4	1

ADDITIONAL DIRECTORY OF LOCAL USE QUARRIES

— OF —

CASS COUNTY.

	T. R. Sec.	
Applegate, Lee		Union
Betts, W. H.	10-12-22	Avoca
Gordon, W. L.	11-11-22	Weeping Water
Gruber, Simon		Union
Harshman, F.	10-12-29	Avoca
Harshman, G. W.	10-12-27 & 34	Avoca
Hepner, Fred	10-12-10	Nehawka
Hepner, Henry	10-12-16	Nehawka
James, Charles	10-12-27	Avoca
Kime, A.		Nehawka
McCarroll, J. E.		Union
Murray, L. C. W.	12-13-30	Maynard
Ost, Fred		Nehawka
Pell, H. F	10-14-17	Union
Pollard, Isaac	10-13-18	Nehawka
Rennard, J.		Plattsmouth
Stohn, C.	10-12-5	Weeping Water
Stein, John	10-13-22	Union
Thacker, L. T.	10-14-4	Union

Clays

Clay suitable for brick work is found in abundance in Cass County.

The Loess is abundant in all sections. This where mixed with valley wash, or alluvium, makes a fairly good brick material. Such bricks are not extremely serviceable, nor are they suitable for ornamental purposes. For general construction work, where too high standards are not required, and where the cheapness of material is an essential feature, Loess brick are not excelled.

The Dakota occasionally furnishes beds of most excellent material for brick and terra cotta work. In our region the clays associated with sandstone are certainly the best. The clay is of an excellent quality and free from objectionable impurities. It works easily, burns well and furnishes a most durable and artistic brick.

The Coal Measures furnish some excellent strata of clay. Interbedded with the limestones are beds of clays of very high quality. One of the most extensive beds of this material, and as yet undeveloped, is on the farm of Mr. Isaac Pollard at Nehawka. It is a red, highly plastic clay suitable for the best grades of brick.

Since clay is very abundant, little value is attached to it, yet many of the beds now undeveloped will in time be called into use.

A large number of excellent clay beds exist in this county. Up to within the last few years extensive works were carried on at Louisville, Weeping Water, and Plattsmouth. For various causes the works at all of these places are now abandoned.

The works at Louisville were at one time among the most extensive in the state. Thousands of brick were produced annually. Extensive machinery and appliances then in use are now entirely removed.

The Works at Weeping Water produced both ordinary and pressed brick from an extensive bed of Loess. These works though in a sad state of decay still remain intact. ,

The works at Plattsmouth have not been operated for two years.

The only clay industry now operating in this region is at Louisville, where the Omaha Hydraulic Pressed Brick Co. is excavating clay for shipment to their works in South Omaha. The bed from which this clay is taken is a very irregular one. A compiled

section shows 28 ft. of clay from the Dakota Cretaceous formations. This is an excellent clay for the manufacture of brick. The work is operated for ten months each year, employing twelve men during that time. The annual output is 600 cars.

The demand for artificial building material is rapidly increasing. The exhaustion of the supply of lumber is forcing many prospective builders to abandon projects, or resort to stone and brick. Lincoln and Omaha will furnish an increasing market for artificial building material. For these reasons clay deposits in Cass County are especially important. Early settlers employed stone and brick in the construction of their buildings. Many of the old stone houses constructed of the roughest grade of rubble are still standing and in use. Mr. Isaac Pollard at Nehawka was one of the few to construct his own brick works and utilize the product in the erection of farm buildings. From clay and wood at hand he produced in those early days a grade of brick which has proved very efficient and durable.

Sand.

An unlimited supply of good sand fills the river valley and composes the flood plains of the Platte River. Accurate data of the depth of this sand is not obtainable. At places it has been penetrated for 60 feet, while elsewhere bed rock is found at 35 to 40 feet. Three grades of sand are produced; engine, concrete, and commercial. The engine sand is a fine grade used by the railroad companies in their engines to prevent the drive wheels from slipping on the rails. All are familiar with the little turret-like box surmounting the boilers of locomotives. Tubes lead from this close to the drive wheels. The sand for nearly all of the engines on the Burlington railroad system comes from pits along the Platte River.

The concrete sand is a coarser sand, containing much gravel. This is excellent material for mixing with crushed limestone and cement, forming concrete for foundations and sidewalks. The commercial sand is a medium grade between engine and concrete. It is used in all grades of constructional work where a good grade of sand is required. It is fine grained, free

from clays and soil, and contains a small per cent of gravel. Platte River sand of the commercial grade is found on sale in most of the lumber yards of southeastern Nebraska.

Recently in the operation of the pit at Louisville a thin bed of gravel was encountered in dredging. It is quite probable this will not prove to be extensive.

I am indebted to Mr. George Rand, now foreman for Messrs. Atwood & Co. at Louisville for notes concerning the following sand works.

One of the first pits opened in the county was the old pit east of the railroad section house at Cedar Creek. This was opened in 1889 by Mr. A. H. Parmalee, and operated for four or five years. Loading was done by teams and scrapers.

Only sand from above the water table could be obtained by this method; hence the best grades remained. For this reason the method was abandoned. No fair estimate can be made of the amount of sand excavated, but it would certainly run far into the thousands of cars, as is evidenced by the size of the pit.

One-half mile east of this pit is a small artificial lake, the result of sand dredging with a boat dredge. This was owned and operated by Mr. Hugh Murphy of Omaha. The first two or three years it was operated by teams and scrapers, as was Mr. Parmalee's pit. In 1887, an old Missouri River dredge was secured and placed in service, which elevated the sand from the water to the cars. This had a capacity of 60 cars per day. The maximum output for one day was 40 cars.

By this method five acres of ground were excavated to an average depth of 15 feet. Ten years were required for this work. The various grades of sand were not kept distinct. A large per cent of this sand was used in street pavement work in Omaha.

Upon the expiration of the lease this work was abandoned. Two dredging stations are now in active operation by Messrs. Atwood & Co., one at Louisville and one at Cedar Creek. These pits are operated by means of a 3000 pound dredge called a clam shell. This is swung from two cables extending across the pit. The dredge is attached to one end of a cable, the other end of which winds about a drum operated by steam. The clam shell is drawn out on the cable by gravity to the center of the pit, where it is

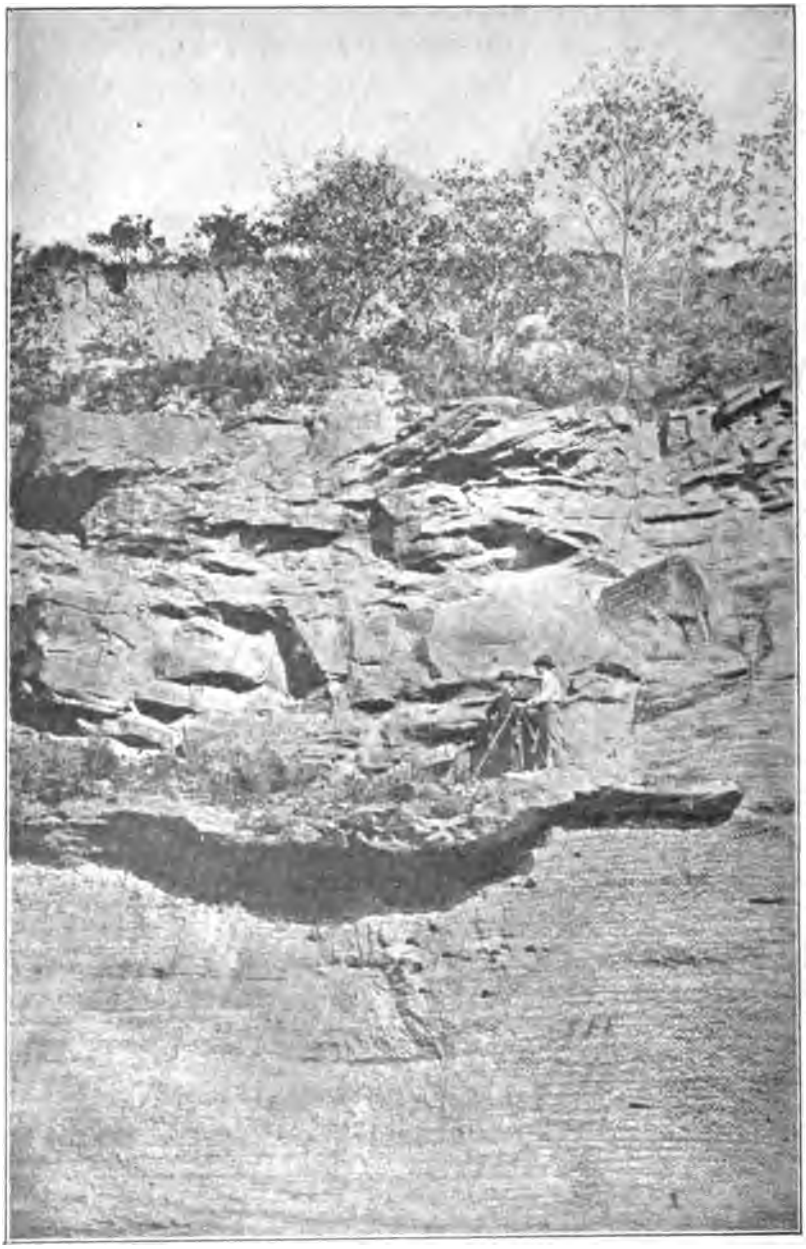


FIGURE 13—A portion of the working face of the Cullom gravel pit, showing gravel beneath, with Dakota sandstone and Loess above.
(*a*) Loess, 35 ft. (*b*) Dakota sandstone crossbedded, 50 ft. (*c*) Dakota gravel, 24 ft.

loosened automatically from the carrier and sinks to the bottom, where it closes by its own action; it is then drawn up and pulled along the cables to a point above a car on the side track; here a block pushes a lever and forces the shell open. In this way the sand is dropped into the car. The brake on the drum is released and the clam shell is free to begin another trip to the bottom.

The sand pit at Cedar Creek was opened in 1898. From 300 to 400 cars were first taken out with teams. After this the machinery, of which the clam shell dredge is the chief part, was installed. Since then 1500 to 1800 cars per year have been shipped. The three grades are engine, concrete, and commercial sand. Cottonwood logs were encountered; one 60 ft. long was 7 ft. underground. This artificial lake is now stocked with fish. The size of this lake is about 1/8 of a mile long by 250 ft. wide.

The Louisville pit was opened July 29th of last year. Approximately 100 cars were shipped the first year. The same kind of sand as at Cedar Creek is encountered. Mr. Rand reports that at 18 ft. below the surface of the water he struck a black material 8 inches thick. This does not extend as a continuous bed over the entire pit; 15 ft. from the place of first contact it was missed. Sufficient excavating has not been done at this writing to learn its probable extent. A piece of this material, examined after it was considerably weathered, shows it to be a highly carbonaceous shale, approaching a lignite. This may be taken as slight evidence that the Platte River is now filling its channel. The sands and gravels of the state, now in course of preparation by a dustries of the state.

Occasional small beds of drift sand produce an excellent quality of sand for all plaster and cement work. These beds are never extensive and are operated in a very limited way for local use.

The sand of this region will be fully discussed in a paper on sands and gravels of the state now in course of preparation by a member of this Survey.

Gravel.

Banks of excellent gravel appear at places along the Platte River. This gravel is in the Dakota formation. A description **of these deposits will be found under "Stratigraphy."**

FIGURE 14—Conglomerate, known locally as peanut rock because of its close resemblance to peanut candy of the confectioners, consisting of quartz and jasper pebbles, united by a brown iron cement. Louisville gravel pits, Dakota cretaceous. From the collections of Hon. Charles H. Morrill.

This gravel is very valuable for roofing purposes, for sidewalks, drives and ballast. This makes a very durable and attractive material for such purposes. The cementing material often reaches a sufficient excess to unite the whole mass into a conglomerate resembling peanut candy, hence the popular name "peanut rock."

Two miles west of Cedar Creek is a large bed of such gravel. A few years ago quarrying was carried on extensively. The gravel was taken out, screened, and loaded on cars. The size of the opening indicates that the total product was many thousand cars. This too was operated by Messrs. Atwood & Co. who are unable to give us totals. Stripping became too heavy for profitable operation and the work is now abandoned.

The Cullom pit, formerly operated, but for a number of years abandoned, has recently been reopened. A sidetrack has been laid and extensive production is contemplated. This too, has yielded excellent gravel. This bed is deeper than the one west of Cedar Creek, but also requires more stripping. The bed here stands in an immense, massive bank, a view of which is given. It is the only extensively operated gravel pit in the county. The gravel industry can never be of as long continued operation, or as extensive as the sand, but must yield a profit to operators and be of benefit to the section. The so-called peanut rock is of value chiefly as a curiosity.

Soil.

The soil of the region is very fertile. It is Loess mingled with a varying per cent of organic matter from the roots and stems of plants, chiefly grasses. The subsoil, except in some of the valleys, is pure Loess, a clay-like substance containing much quartz sand and a little clay. The thickness of the soil is exceedingly varied. On the gently rolling up-land it attains a thickness of several feet. In the more rolling regions where erosion is rapid, the mantle of loam thins, and often the yellow subsoil is exposed. The bluffs are covered by little or no soil.

In a few limited regions disintegrated limestone plays a part in soil making. This occurs on the talus-like slopes and the margin of alluvial deposits in limestone regions.

The valleys have a more or less extended alluvial area presenting a soil rarely excelled in richness and ability to produce abundant crops successively.

The soil of this county contains the essentials for the production of all fruits and grains of a temperate region.

The following analyses of soils were made by Prof. Milton Whitney of the U. S. Dept. Agric. at Washington.

No. 2073. Mechanical analysis of subsoil 6 in. to 36 inches from Cass County, near Weeping Water, Sec. 8, Township 10, Range 11. Soil No. 2-20-7-93.

Moisture in air-dry sample	Organic Matter	Gravel	Coarse Sand	Medium Sand	Fine Sand	Very fine Sand	Silt	Fine Silt	Clay
4.17	4.82	0.00	0.00	0.04	0.19	36.37	23.47	4.70	26.70

The soil on the hills is rendered fertile by the clay constituents of the subsoil and by its ability to receive and retain ground water. This water gradually ascends by capillary action; in this way moisture is continually supplied to the rootlets of the growing plants.

Timber.

Though timber is not a geological product it bears such close relation to the soil that it is deemed worthy of mention in this work. Native trees are abundant along the waterways. Oaks, walnut, hickory, willow. boxelder, etc. are indigenous to the soil. Timber is becoming so valuable that the most careful possible use should be made of trees. A saw mill is now operated at Louisville by Mr. John Jackman. Cottonwood, elm, willow and oak logs are sawed into lumber. Some timber along the Missouri is also being cut for lumber.

HYDROGRAPHY.

Water is so universal and so concealed in its effective operation that few give it serious consideration as an economic resource. This is especially true where wells are shallow and where irrigation is impossible or unnecessary. When crops fail, such failure is attributed to atmospheric conditions, a lack of rain, or too much wind, though it is known to be due to an insufficient amount of moisture near the surface of the soil. A failure in the water supply in wells brings us nearer an accurate solution of the problem, but even then the explanation is indefinite. A little consideration will convince the reader that water is the greatest economic resource of an agricultural county. The nature of ground water is now well understood. Few still cling to the idea that there are great veins coursing beneath the ground much as the blood flows through our bodies, and that such veins must be struck in boring or no water will be obtained. Such cases do exist, but they are exceedingly rare.

It is more nearly accurate to think of the source of our water supply as being in a great sheet of water bearing material conforming to the hills and the valleys, with its edges exposed where springs occur. Above this is the great covering of moist earth, (the subsoil,) and still above this, the soil we cultivate. Water sheets and sheet water are familiar to all, and while the popular conception varies somewhat the essentials are the same. Conditions controlling ground water are various; the chief are the amount of rainfall, amount of run-off, amount of surface evaporation, and nature of beds receiving the water. The amount of rainfall, while not high, is sufficient for agricultural purposes. The annual average is 31.28 inches. It is worthy of note also that the greatest amount of rainfall occurs in the growing months from April to August inclusive, while the remaining seven months of the year are comparatively dry. The nature of the ground is such that much of the precipitation is lost by run-off. The mature drainage conditions and the nature of

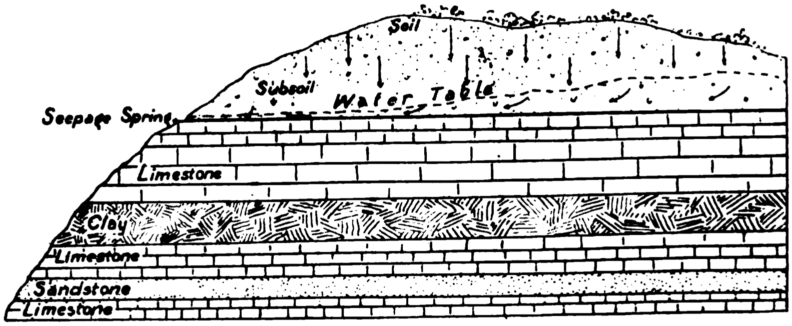


FIGURE 15—Showing the course of water under ground, and its escape in surface springs.

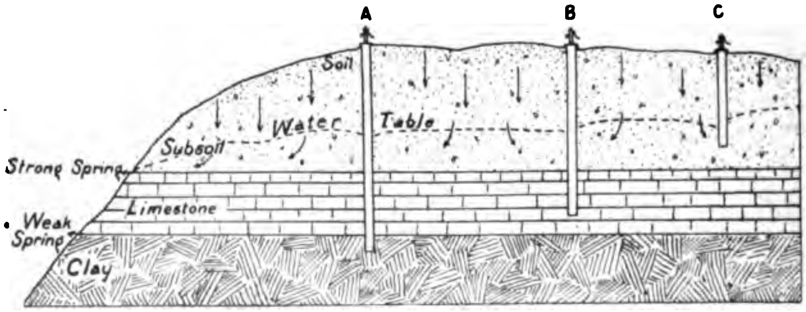


FIGURE 16—Showing hillside springs and wells of varying depths penetrating subsoil and bed-rock. A and B, dug in compact material yielded little water, and that often brackish. C, being in loose material, has a constant supply.

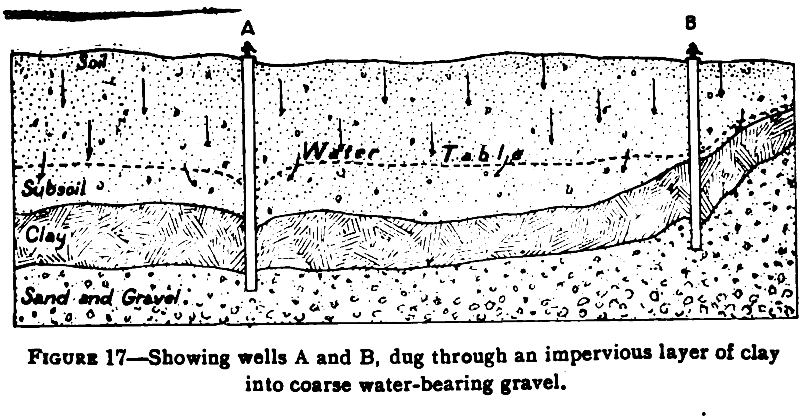


FIGURE 17—Showing wells A and B, dug through an impervious layer of clay into coarse water-bearing gravel.

the soil render the run-off possible. This run-off is highly disadvantageous, both in the loss of moisture in the soil and in the damage done to crops by erosion. The farmer evidences his recognition of these principles when he avoids plowing the furrows up and down the hills and runs them as nearly at right angles to the ravines as possible. The amount of surface evaporation is considerable; the exact amount is impossible to estimate. Recent experiments seem to point to the conclusion that if proper methods of soil culture are employed the amount of surface evaporation can be decreased and much water conserved in the soil, thus rendering a much larger yield of grain per acre possible. The nature of the water-bearing beds is a subject which is given little consideration in agricultural pursuits and in well construction, but which is one of the utmost importance. To be an excellent water-bearer the strata must be loose, coarse grained, and very porous. Such conditions are found in gravels and sandstones; hence the Drift gravel and Dakota sandstone are the best water-bearing beds in Cass County. Such beds when overlaid and underlaid by strata which will not permit of the ready escape of water, afford artesian wells. The Dakota sandstone far to the north of us affords flowing wells but in our region such wells are impossible, since they are bounded above by porous clays which permit the escape of the water. The Loess contains much sand and fine particles of clay which render it minutely porous. This absorbs the water and permits its slow passage to lower points of escape in wells or springs, or by capillary action to the soil above and the surface, where it is taken by plants or evaporates. Perhaps Cass County's agricultural wealth is due as much to this finely porous subsoil as to any single cause. The limestones, being only slightly porous can receive or yield only a very small quantity of water; hence in these beds the supply must be sought only between strata, and then is quite insufficient.

It is impossible at this time to give a general discussion of the passage of water underground. Those who may wish a treatment of this subject may find it in the Water Supply and Irrigation Papers published by the Division of Hydrography of the United States Geological Survey. These are issued free. Especial treat-

ment will be found in Nos. 29 and 67. Figures are here introduced to partially explain this subject.

Practically all the wells in Cass County receive their supply from sheet water. The sheet water is that portion of the subsoil completely saturated with water. The surface of this zone is called the water table. The depth from the surface of the ground to this water table varies with conditions. The water table is nearer the surface in valleys than on hills. This is a natural condition, for the water is seeking a level. The water passes slowly underground; therefore the water table is not level. In spring regions the water finds an escape; hence the water table is lower in such places. In times of drouth the escape of water by springs, wells, and evaporation exceeds the amount received from rains, and the water table must gradually sink to a lower level, while during a wet season the reverse occurs. This accounts for wells becoming dry during drouths and filling again when rainy periods occur. A consideration of the zone saturated with water and the water table explains why valley wells are more shallow and furnish a more permanent supply than wells on the up-land. In Cass County the best water-bearing formation is the Drift gravel encountered just beneath the Loess, and above the sandstone or limestone. This gravel is not very thick, however, and occurs so irregularly that in digging there can be no certainty of finding it, but if found below the water table it furnishes a steady supply of good water.

In the northern and northwestern parts of the county many of the wells enter the sandstone. These furnish abundance of good water. The Dakota sandstone is an excellent water-bearer. As has been noted it is from this formation that, under favorable circumstances, artesian water is found. The interstices between the particles of loose sand afford ample room for large quantities of water and permit the slow seepage to openings at wells or springs. Some idea may be gained of the value of this formation as a water-bearer when it is known that the city of Lincoln obtains an ample supply of excellent water from wells sunk into this sandstone.

A few wells located upon the sandy flood plains of the Platte River obtain their supply by seepage from that stream. The

entire depth is in sand and the height of the water table varies with the rise and fall of the river.

Most of the wells are sunk into the great Loess (yellow clay) sheet, which is a good water-bearing formation. It is composed of fine particles of sand and various other materials, which render it minutely porous; this, then, acts as a sponge.

Much difficulty is experienced in regions of limestone exposures. Here the water varies, due to the ready escape of water along the rock ledges. In such places an abundant water supply is impossible. Only partial relief can be obtained. One method which may be employed is to sink shallow wells, each of which furnishes a small supply. Occasionally sufficient water may be found in the bed of a ravine. The most successful method yet employed is to sink a well on the lower tableland or bottom and conduct the water by pipes to the desired points. Wind power with automatic regulators may be used and while the method is not the most desirable, it is found to result in less inconvenience than many other methods.

In no case should an attempt be made to penetrate the limestone. Such work is almost certain to result in failure. One of the most marked experiences of this kind was that of Mr. Geo. Woods on his farm one mile south of Weeping Water. The record of this well shows that an unsteady supply of water was obtained after having dug 110 and drilled 200 feet (a total of 310 feet). This well, at a cost of $1000, with $100 additional for pump and mill, was yielding ½ barrel of water per day at the time of record. Our records show a number of similar experiences within the limits of the county. One farmer near Cedar Creek, after several expensive failures, found it necessary to dig a well and erect a mill a half mile from the farm buildings and conduct the water to them in pipes. In this case the mill is controlled by lines of wire. While a few successes result from penetrating the limestone the undertaking is always uncertain, and should be attempted only as an expensive last resort. What, in some sections of the interior, is called the Platte river sheet, is a misconception. It is the sheet or water zone noted above. Were it possible to receive a supply from the Platte River it could be obtained only after penetrating several layers of limestone.

Springs.

Springs occur under a variety of conditions. In our region where the water-bearing beds are of comparatively uniform texture and irregularly deposited, springs appear where the ravines have cut below the level of the water table. This permits an escape for the water, which slowly flows in from the surrounding hills. When the water coming to the surface flows to one channel the spring bubbles out in a single opening. Such conditions exist where the beds become more porous in a small area or where a small ravine existed at time of deposition or previous to it. If this water fails to unite in a common channel, numerous small openings occur resulting in seepage, areas, bogs, and even marshes. Springs also occur where limestone or other impervious beds are overlain by water-bearing beds. The water in its seepage downward meets the impervious layer and follows along it to an outcrop, if such occurs, below the water table.

Some excellent springs are found in Cass County. The region containing the largest number with the strongest flow is in South Bend precinct T. 10, R. 12 E. One spring in T. 10, R. 12, Sec. 33 is reported to yield a flow almost equalling the springs which supply the State Fish Hatcheries just across the river. The springs obtain their supply from the Dakota sandstone. Springs flowing less than 100 barrels per day are quite common along the sandstone exposures. These springs are a part of a line of springs occuring along the Dakota outcrop from Dixon to Jefferson counties.

Springs occur in limestone regions but fail to discharge through one channel; hence are commonly only large seepage places. A most beautifully located spring pours from above a ledge of limestone at the base of a steep hill on the farm of F. B. Larsh T. 10, R. 14 E. Sec. 18 S. E. 4 S. E. 4. This spring has an estimated flow of two barrels per minute. The water after passing through a milk house supplies a fish pond.

Irrigation from it has never been attempted, since the annual rainfall is amply sufficient for all agricultural purposes.

Water in Cass County is generally hard, deriving its salts from the soils and stones in its passage downward. A few wells are reported as containing soft water. The water is much harder in

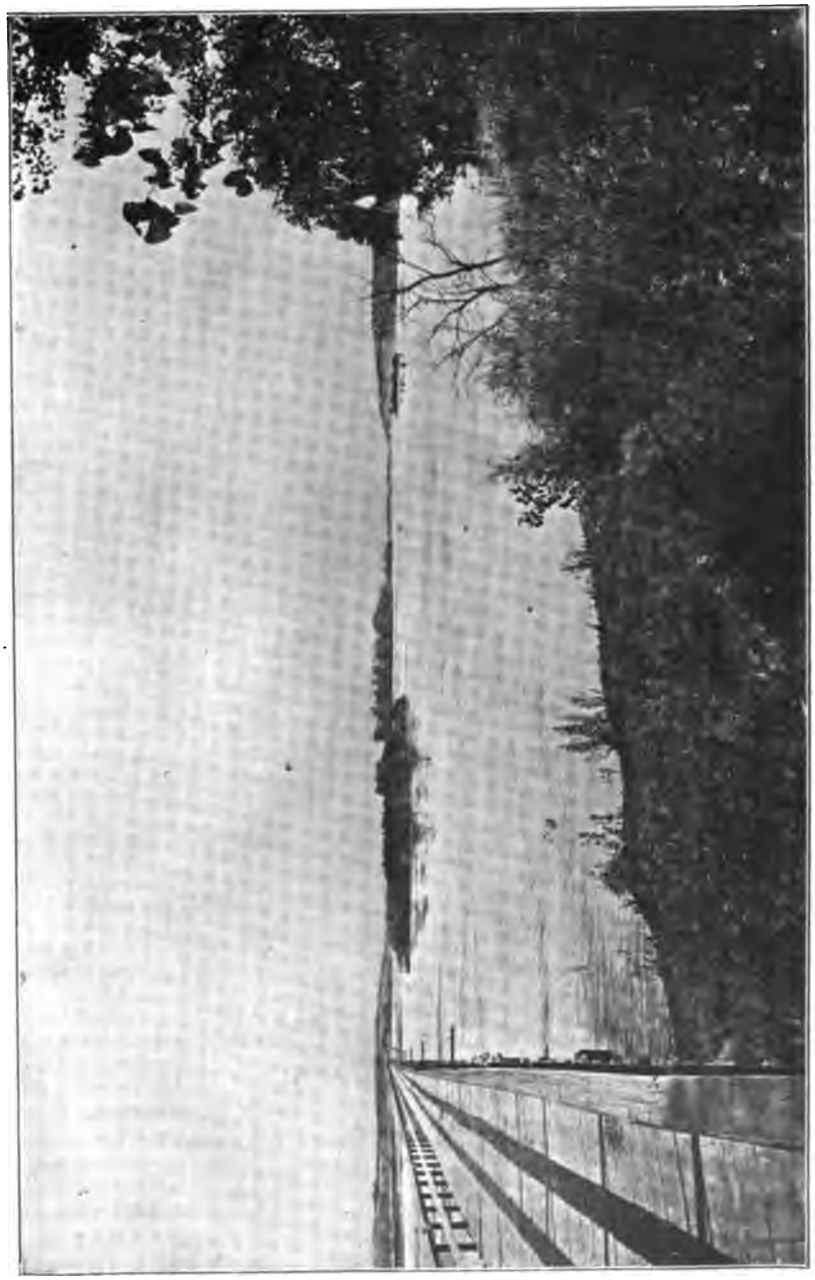


Figure 18—Platte River scene at Louisville, Nebraska, Geological Expedition of Hon. Charles H. Morrill, 1901.

valleys where it passes through limestone ledges before reaching the wells.

Mr. H. W. Loyd at Union has two wells, one 470 feet, another 500 feet. both yielding salt water. This water is said to have medicinal properties and as such is placed on the market. Neither well flows.

Rivers and Creeks.

Missouri River. The Missouri River flows along the eastern boundary of Cass County. In this portion of its course it is a little more than 1000 ft. wide. Its flow is rapid with many small, cross,(or irregular) currents, which are constantly changing, thus breaking the placid appearance of its surface. At the present time the river is meandering so that it is encroaching upon the west bank almost entirely across the county. Between Rock Bluff and Plattsmouth a portion of the flood plain which has long existed is now being cut away. The great steel railroad bridge at Plattsmouth is entered directly from the bluffs on the west side, while on the opposite side a long approach is necessary. At this point in its course the river grade is 1.06 feet per mile. During early times this was the great transportation highway which brought explorers and settlers and which was their means of exchange and communication with the outer world. Since railroads have gained the ascendency over river traffic few boats pass this part of the river. A cable ferry is now in operation at Plattsmouth as a summer means of crossing. The ice serves as a sufficient means of winter passage. At no place in the county is water taken directly from the river for city supply, but at Plattsmouth water is drawn from the flood plain a mile from the channel. The river is sought to a small extent for pleasure boating at Plattsmouth.

Platte River. The Platte River before reaching the limits of Cass County has lost its broad valley and its many-channeled character and is confined by steep walls of stone to a narrow flood plain. It is forced to occupy one principal channel with a few branches running independently for only short distances. The water is continually falling into depressions and over obstructions and bubbling up again, so that the surface is never smooth and the water never flows quietly along. The average grade is 3 feet

FIGURE 19—Destructive ice gorge at the Union Pacific R. R. bridge, Louisville, Nebr., March, 1903.

FIGURE 20—Break in railroad bridge at South Bend, Nebraska, caused by destructive ice gorge, March, 1903.

per mile. The individual channels vary greatly in width, rarely exceeding 300 feet. From bank to bank the river approximates three-fifths of a mile. Sand bars are quite numerous, small, and mostly barren. A few have become permanent and wooded with willow, boxelder, and cottonwood. These are properly termed islands. One large island is opposite Cedar Creek and another below Cullom. The Platte River is of little direct value from an economic standpoint. It is crossed by two railroad bridges at Oreapolis, one at Louisville, and one at South Bend. A wagon bridge at Louisville affords opportunity for that sort of traffic. The terraces have already been noted.

Weeping Water Creek with its tributaries is important as a drainage channel, and affords excellent opportunities for stock raising and especially stock feeding. The smaller branches, as they pass from farm to farm, are bordered by pastures and feed lots. This running water is a source of profit. Yet the streams often result in detriment as conveyors of contagious disease from the upper portions to farms below. This stream receives its supply from run-off and seepage from the Loess. The stream is ordinarily small. In fact, during dry seasons, the flow entirely ceases in portions of its course below Weeping Water. At times of excessive rains it is converted into a raging torrent, flooding its bottoms and sweeping away fences and low bridges. In bridge construction provision must be made for a rise of twenty feet. An excessive rain near the source results in maximum flood conditions at the mouth some ten or twelve hours later. Farmers construct fences in such a way that they may be swept aside and easily replaced when the flood has receded. This stream is doing little work of erosion except at times of flood. During early settlement it played an important part as a producer of power, but since the burning of the old stone mill at Weeping Water it is no longer used for water power. Mills were located at a number of points, but steam has forced the abandonment of all such sites. Because of its great fluctuation in amount of discharge dam construction is difficult and expensive.

Only a small portion of the course of Salt Creek is through this county. It flows slowly and exhibits wide meanders. The timber along its course is excellent. It is turned to no economic

account beyond the production of a small amount of ice. Just over the border in Saunders County it furnishes power for a large flour mill.

Four Mile Creek in the northwestern part of the county is a small meandering stream receiving the drainage from a large, comparatively flat basin. This flows through an excellent stock feeding district and is a water supply for that industry.

Cedar Creek is more than a large brook. Much of its course is over stone bottom and is bordered by trees, making it picturesque. This stream was used for many years to furnish water power for a small flour mill. A lack of sufficient water supply forced the abandonment of that industry. Numerous small brooks occur but none of sufficient size to merit special notice.

The streams, ponds, and small lakes are everywhere utilized for ice production. The ice is generally stored for local consumption. Many farmers have provided small ice houses in which they store a supply for themselves and the use of their neighbors. At all of the important towns is to be found a firm which makes ice storage and distribution its special business. At Weeping Water this industry has assumed commercial importance. Each winter many cars are loaded for distribution at various stations along the Missouri Pacific Railway. This industry furnishes employment for laborers at an idle time.

Below is given a compiled list of well records by precincts, as far as we have been able to obtain them. showing number of wells recorded, average depth of well, average depth of water, and cost of well:

(See next page.)

SUMMARY OF WELLS OF CASS COUNTY

Township	Range	Number of Records	Average Depth of Wells in ft.	Average Depth of water in ft.	Town in Precinct
12	13	10	57. ft.	13. ft.	Plattsmouth
12	12	8	32.	9.6	Cedar Creek
12	11	5	68.8	9.5	Louisville
12	10	14	84.6	21.	South Bend
12	9	12	68.2	26.	Greenwood
11	14	5	78.4	4.6	Rock Bluff
11	13	20	57.4	19.	Murray
11	12	25	44.	15.6	" & Nehawka
11	11	19	65.3	19.5	Manley
11	10	15	54.5	10.4	Murdock
11	9	13	80.	41.6	Alvo
10	14	4	55.5	20.	Union
10	13	22	45.7	12.3	Nehawka
10	12	32	42.	13.6	Avoca
10	11	12	71.	12.2	Weeping Water
10	10	17	66.1	24.5	Elmwood
10	9	7	70.5	21.	Eagle
Total		230	61.2	17.1	

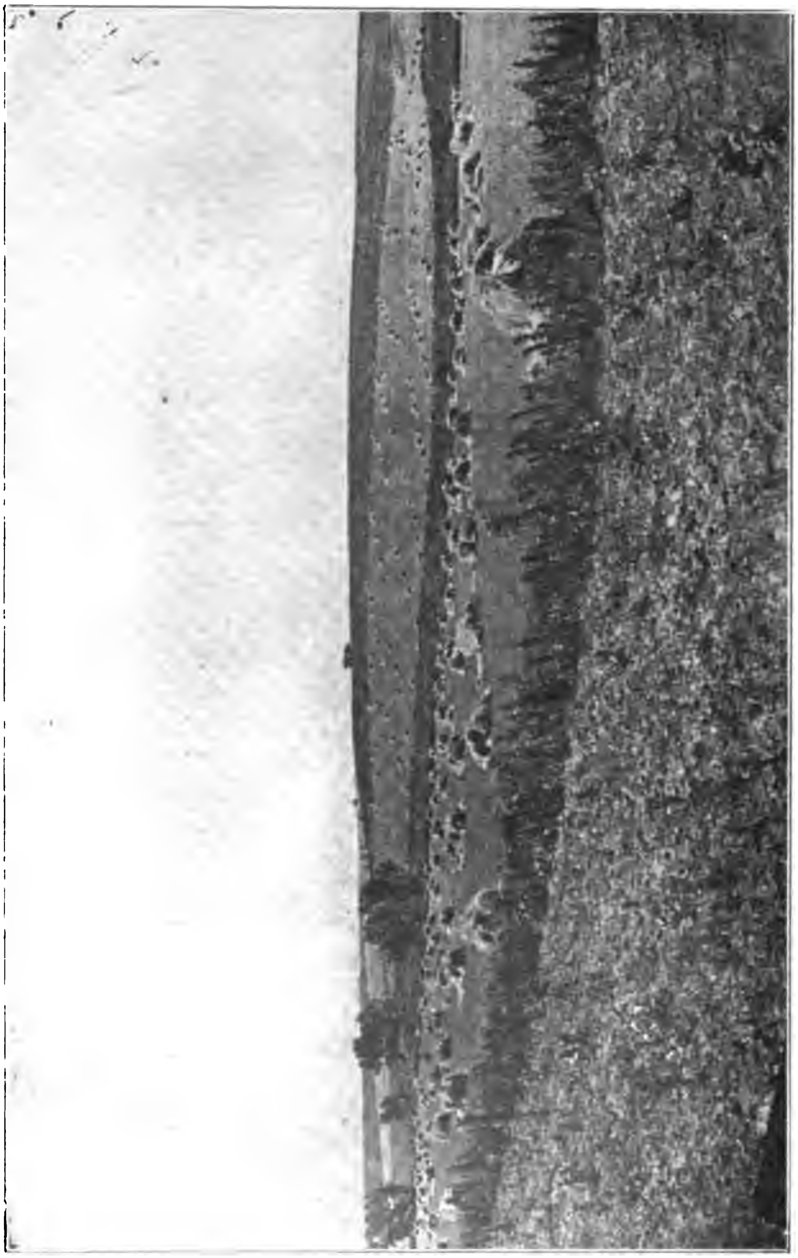


FIGURE 21—Typical Agricultural scene near Louisville, Nebraska Rolling Loess prairie and fields of grain.
Photograph, Geological Expedition of Hon Charles H. Morrill, 1901

The following data concerning the Plattsmouth Water System are furnished by Mr. T. H. Pollock. Secretary of the Company.

The Pumping Station at Plattsmouth was established in 1880 by Turner, Clark & Rawson.

It has a pumping capacity of 750,000 gal, per day.

The stand-pipe is 250 ft. above the city, is 26 ft. in diameter, 80 ft. high, and has a capacity of 320,000 gal. It is 247 ft. above the pump house and 50 ft. above the highest point in the city.

The pressure in the main portion of the city is 100 lbs. and the pressure at the station is 106 lbs.

The water is supplied by air-pressure wells, 65 ft. deep with a 20 ft. brass strainer in each, and distant 800 feet from the pump house. These wells draw water from a deposit of gravel 20 ft. deep, extending to the river and acting as a filter nearly a mile wide.

The river was used as a water supply till 1901 when the wells above mentioned were made.

There are two settling basins of 1,250,000 gal. each; they are both used at once, but may be used separately.

No filters are used except those mentioned.

The average consumption in winter is 200,000, and in summer 275,000 gal. per day.

The regulation for the sprinkling of lawns is 2 hours per day.

Climate.

Below is given some data regarding climate. These reports are taken from the Annual Summary for 1903 published by the United States Weather Bureau. The records, unless otherwise stated, were taken by G. T. Treat, observer at Weeping Water.

Temperature.

Highest July 8th	95°
Lowest Feb. 18th	17°
Mean annual temperature	46.9°

Normal average temperature

Jan. 19.4°	May 58.8°	Sept. 63.6°
Feb. 21.8°	June 69°	Oct. 51°
Mar. 33.6°	July 73.8°	Nov. 35°
Apr. 50°	Aug. 70.4°	Dec. 25.3°

Killing frost, May 3d, and Oct. 8th.

FIGURE 22—Agricultural scene; a Cass county farm near Louisville, Nebraska.

Rainfall. The greatest rainfall ever occuring in the state is reported from Plattsmouth July 6th and 7th, 1898*. At that time 10.69 inches fell.

Total rainfall for 1903, 32.12 in.

Greatest in one month (May) 9.17 in.

Number of cloudy days, 101.

Number of partly cloudy days, 65.

Number of clear days, 199.

*Plattsmouth record.

AGRICULTURAL STATISTICS.

The following agricultural statistics are of interest:

	Average number per sq. mile	Number of counties in state excelling Cass
Cattle	66	22
Swine	67	22
Sheep	1	....
Milch Cows	17	20
Horses and Mules	27	4
Winter Wheat.	30 bus.	34
Spring Wheat	7 "	....
Corn	285 "	Cass stands first
Oats	60 "	27
Rye	2 "	....
Alfalfa	1 ton	....
Wild Hay	28 "	34

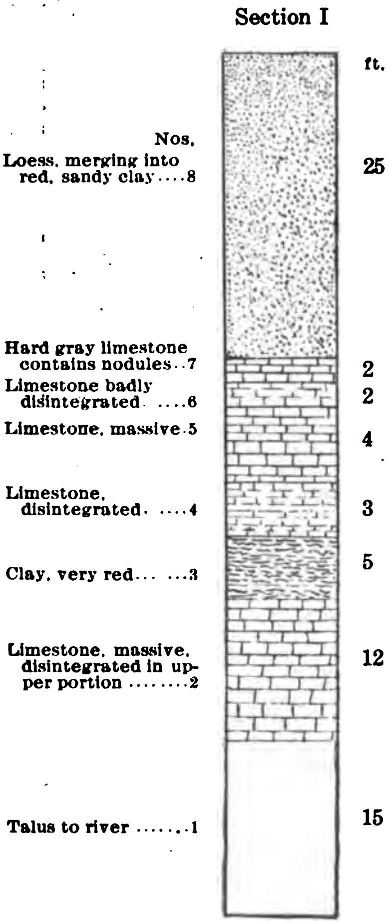


Figure 23.
Section 2 miles west of South Bend, T. 12, R. 10 E., Sec. 11, S. W. 4.

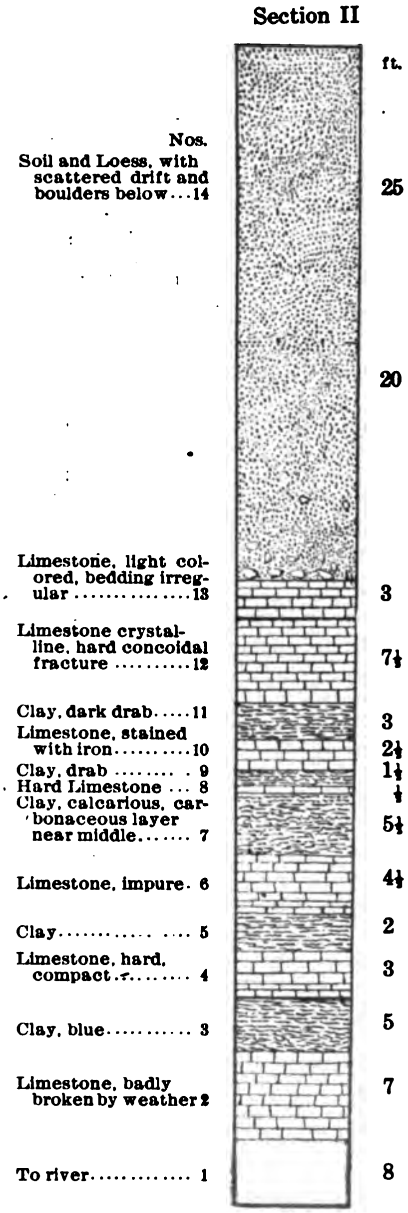


Figure 24
Section 2 miles south-east of South Bend, T. 12, R. 11 E., Sec. 24, N. ½.

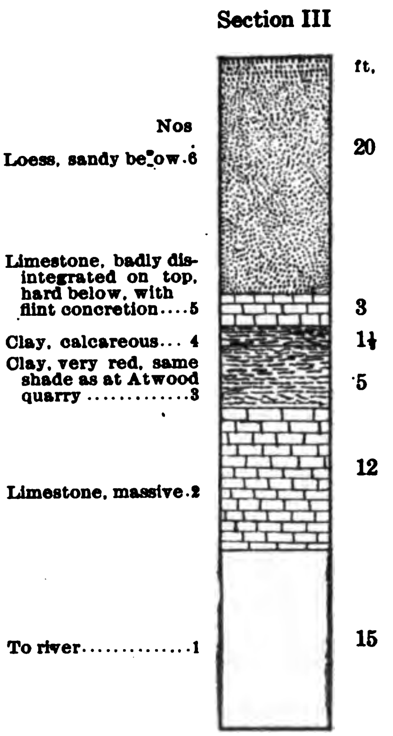


Figure 25
Section one-half mile west of Louisville.

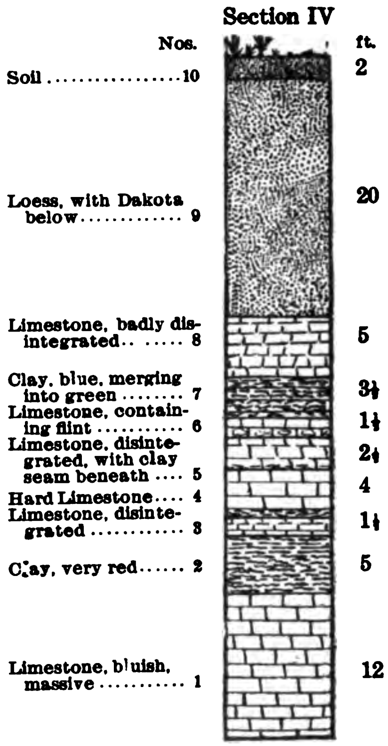


Figure 26
Atwood's abandoned quarry, T. 12, R. 12 E., Sec. 18, S. W. 4.

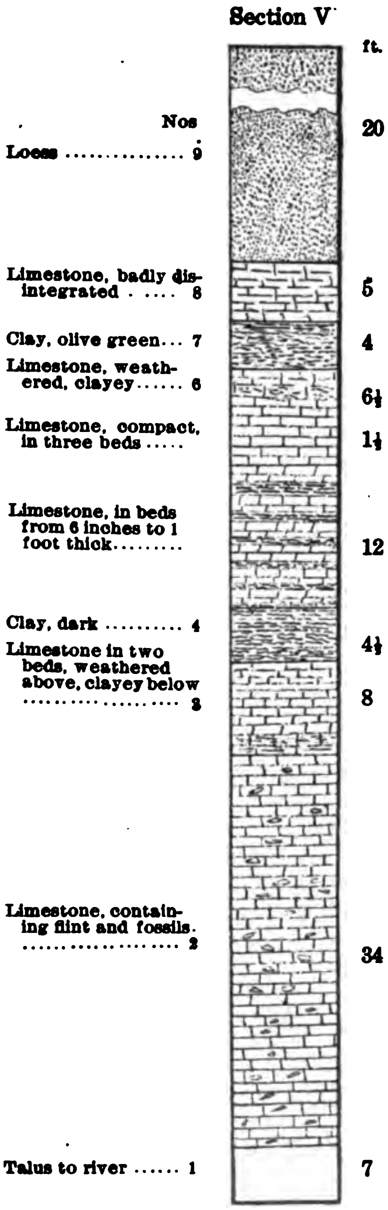


Figure 27
Section 2 miles east of Cullom, T. 13, R. 12 E., S. 33, N. ½

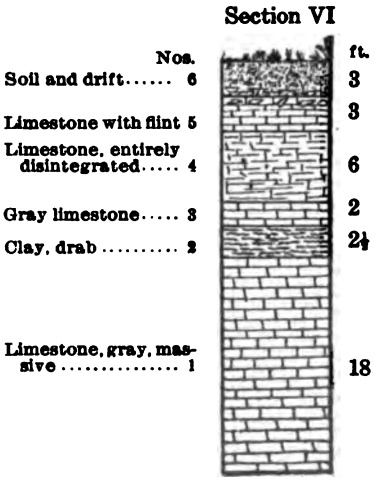


Figure 28
Section at old Swede quarry, T. 10, R. 12 E, Sec. 5, S. E. 4, Weeping Water.

Section VII

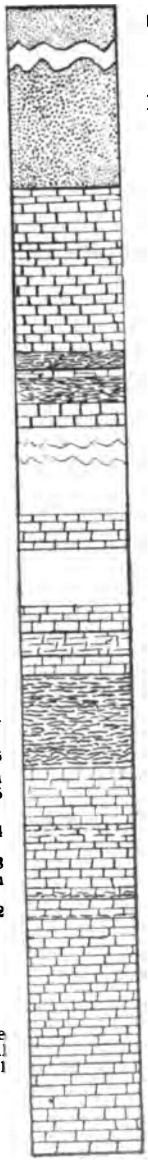


Figure 29
Section at Rock Bluff, T. 11, R. 14 E., Sec. 9, S. W. 4.

Section VIII

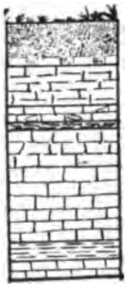


Figure 30
Section at Commercial Land Company's quarry, Weeping Water, T. 10, R. 11 E, Sec. 1, S. E. 4.

Section IX

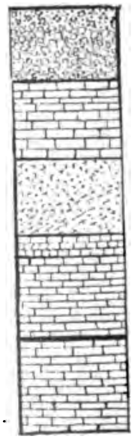


Figure 31
Section at Swede quarry, T. 10, R. 12, Sec. 5, N. W. of S. E. 4.

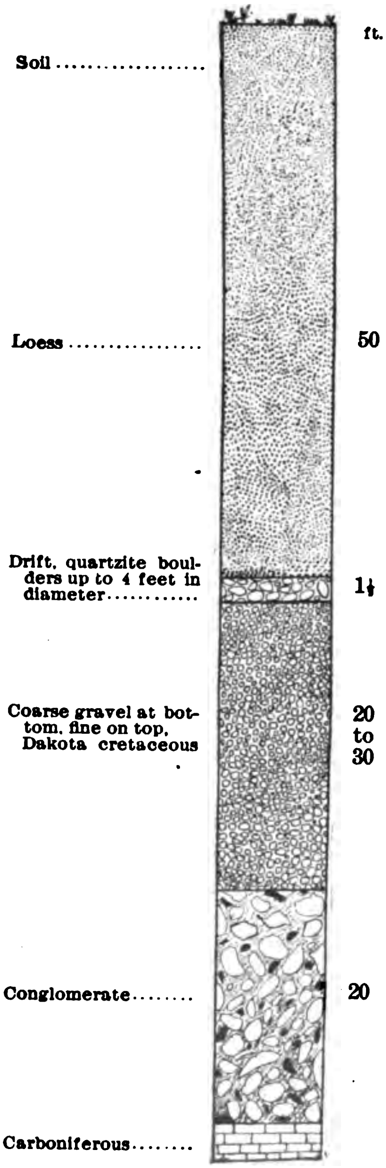


Figure 32
Section at Atwood's gravel pit, 1 mile west of Cedar Creek.

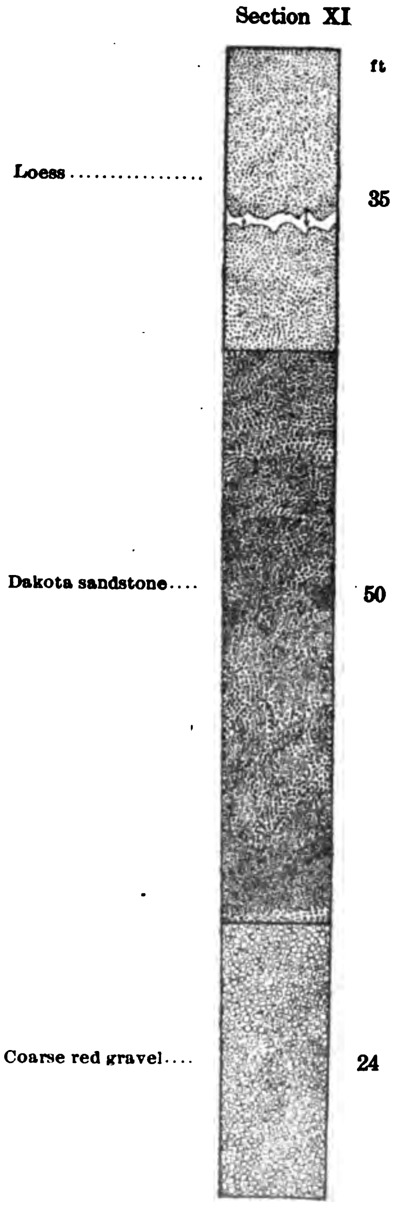


Figure 33
Section at Cullom gravel pits. See figure 13.

PALAEONTOLOGY.

To know what existed here in ages past is interesting to all of us. That animals did exist where now we find only stones, all know, and the nature of those animals is clearly told by their fossil remains. No other equal section of the state exhibits so great a variety of fossil forms as does this one. Not only are these fossil remains interesting, but to one versed in such subjects they are the earmarks whereby he recognizes the various geological formations. And knowing what conditions exist in other regions with similar formations he is able to predict with tolerable certainty what may be found 500 or 1000 feet below the surface in this region.

Cass County limestone is composed to a great extent of fossils cemented together by the gray carbonate of lime. This cement is in most cases softer than the same compound in the fossil itself, hence where these beds are exposed to the action of the weather the fossil is freed by the action of the elements, and awaits the collector. So abundant are these in places that the writer has been enabled to collect a double handful on the space of a square yard.

In the rusty sandstones called the Dakota Cretaceous, traces of life are very meagre. The gravel deposits afford some fossil corals, wood, and what may prove to be nuts and fruit. Occasionally imprints of leaves appear in these stones. Fragments were noted near Louisville, but none sufficiently perfect for identification. From a study here and a comparison with other regions it is now well established that fresh or brackish water covered northern and western Cass County.

Shells. identical with modern forms, occur abundantly in the Loess See Plate 15. Typical Loess fossils of this region have been collected and identified.

It is impossible as well as inexpedient at this time to give full descriptions of fossils of either of the several geological formations. That is reserved for a complete work now in course of pre-

paration. A list of fossils is given here in explanation of the plates, with the briefest possible notes, hoping it may prove of value to those correlating this region with others, or of service to teachers, amateurs, and others making private collections. Specimens in the Museum of the University of Nebraska, some of which are evidently new species, are reserved for final identification and classification.

Besides the localities given, fossils were noted in many other places, though collections were not made.

A LIST OF FOSSILS OF CASS COUNTY.

FROM THE COLLECTIONS OF HON. CHARLES H. MORRILL.

As most people are well aware, the workable beds of rock, clay, sand, gravel, stone, etc., constitute resources of considerable importance to any community. Anything adding in any way to our knowledge of these workable beds is of real, not imaginary value Since it so happens that about the only reliable way of recognizing beds of rock and clay is by means of the fossils they contain, it follows that a report of the fossils is not merely of theoretic but of strictly practical interest.

It is believed that the accompanying figures will serve the public in identifying the fossils of their region and that few descriptions are really necessary here. Those who may wish to pursue the matter further are referred to the reports published by the neighboring states Iowa, Missouri, and Kansas.

Protozoa

Fusulina secalica Say.

This little fossil is exceedingly abundant. It thrived in the carboniferous sea in countless numbers. It was this little animal which extracted most of the carbonate of lime from the sea water to form our present rocks. Few beds are destitute of this form while it is the chief constituent of many.

Locality. Weeping Water, Cedar Creek, and Nehawka.

Porifera

Amblysiphonella prosseri Clarke.

Cass County is the only region from which this sponge has ever been collected.

Locality. Weeping Water, Nehawka, and Rock Bluff.

EXPLANATION OF PLATE

A. Fusulina secalica, natural size

B. Amblysiphonella prosseri, natural size

From specimens in the collections of Hon. Charles H. Morrill.

A. RICE STONE, FUSULINA SECALICA

B. SPONGES, AMBLYSIPHONELLA PROSSERI

Coelenterata

Campophyllum torquium Meek.

This coral is very abundant. It is one known locally as a sheep horn.

Locality. Weeping Water and Nehawka.

Zaphrentis sp.

Locality. La Platte, across the Platte River from Oreapolis.

Syringopora multattenuata McChesney.

Locality. Weeping Water.

Lophophyllum profundum.

This coral is very abundant and is widely distributed.

Locality. Weeping Water, Louisville, Cedar Creek, and Nehawka.

EXPLANATION OF PLATE

Fig. 1. Zaphrentis sp.
Fig. 2. Syringopora multattenuata
Fig. 3. Campophyllum torquium
Fig. 4. Lophophyllum profundum, side and top views of several specimens
All figures natural size
From specimens in the collections of Hon. Charles H. Morrill.

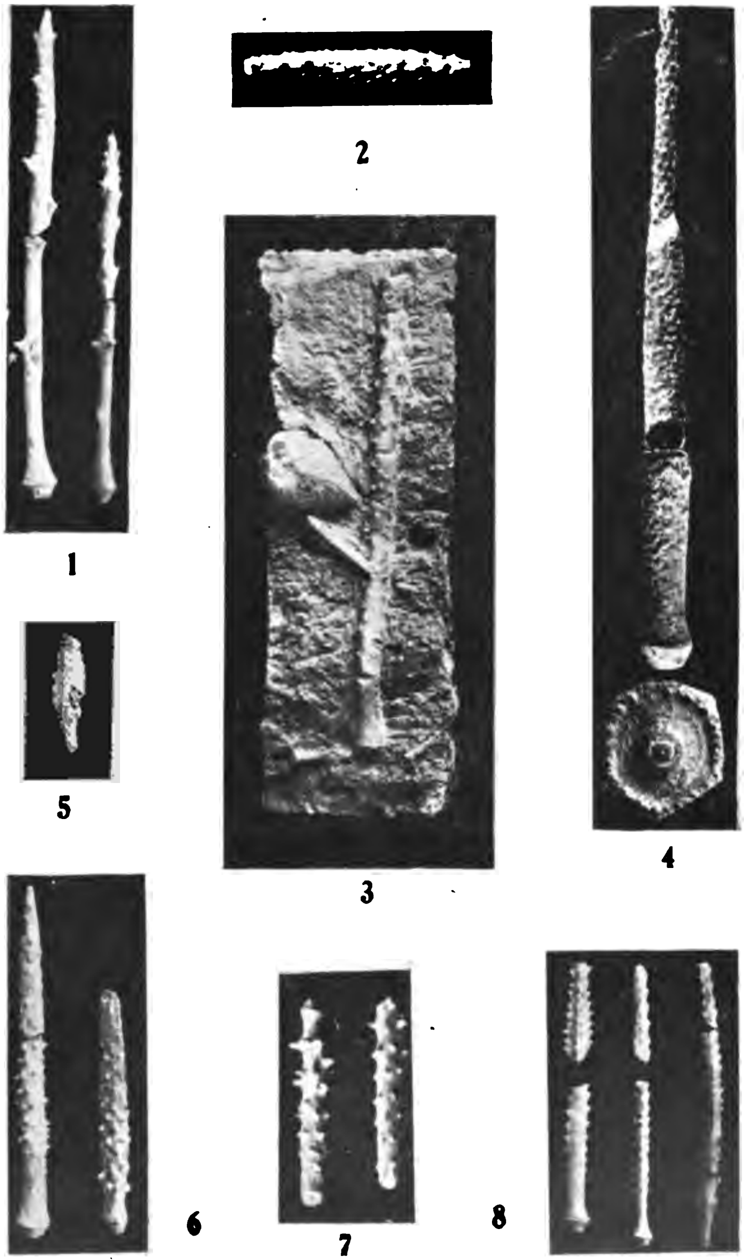
CARBONIFEROUS CORALS OF CASS COUNTY

Echinodermata

Archacocidaris triserrata Meek.
Locality. Weeping Water and Cedar Creek.
Archaeocidaris agassizi Hall
Locality. Weeping Water, Cedar Creek, Louisville.
Archaeocidaris aculeata Shumard.
Locality. Weeping Water, and Cedar Creek.
Archaeocidaris megastylus Shumard.
Locality. Weeping Water, Louisville, Cedar Creek, Cullom, Nehawka, Rock Bluff.
Archaeocidaris dininnii White.
Locality. Cedar Creek.

EXPLANATION OF PLATE

Fig. 1. Archaeocidaris megastylus, spines of
Figs. 2&3. Archaeocidaris agassizi, spines of
Fig. 4. Archaeocidaris agassizi, spine and plate of
Fig. 5. Archaeocidaris biangulata, spine of
Fig. 6. Archaeocidaris aculeata, spines of
Fig. 7. Archaeocidaris dininnii, spines of
Fig. 8. Archaeocidaris triscererata, spines of
All figures natural size
From specimens in the collections of Hon. Charles H. Morrill.



SPINES AND PLATES OF FOSSIL SEA URCHINS

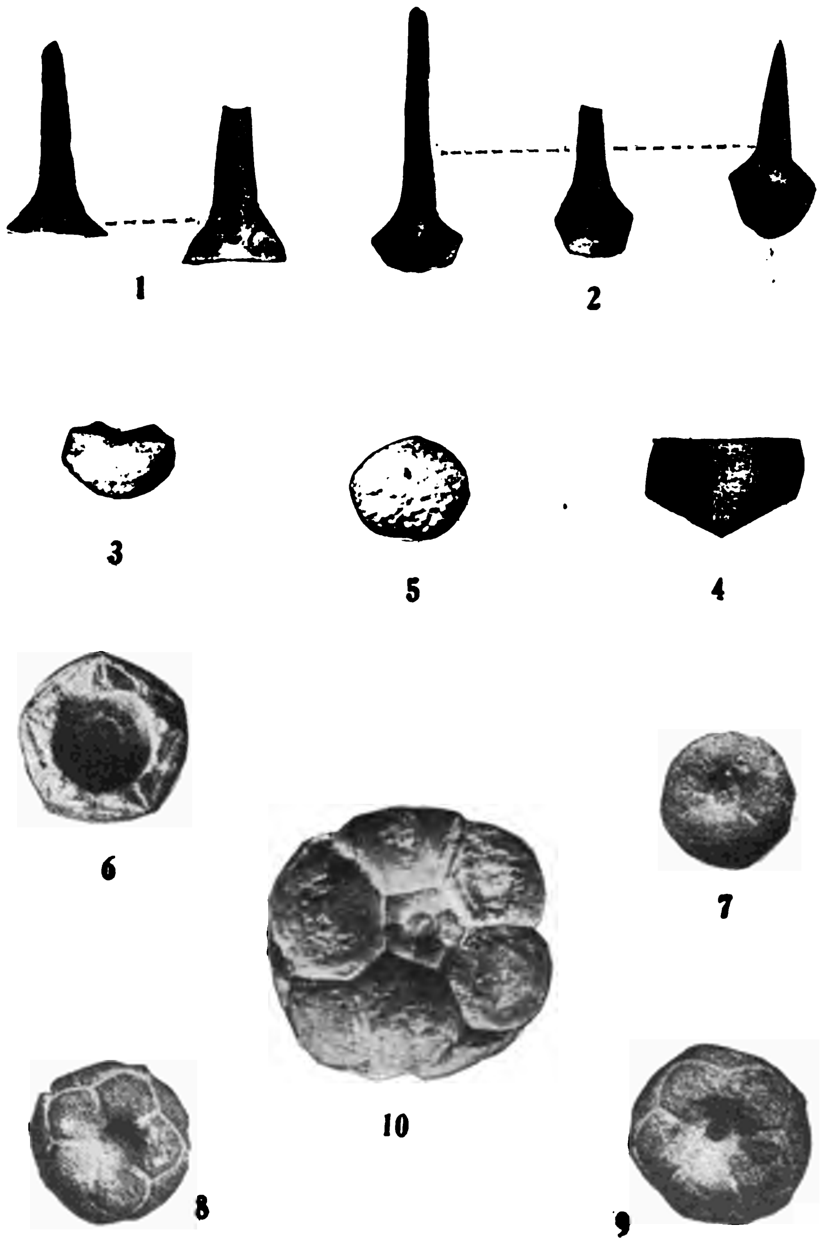
Zeacrinus acanthophorus Meek and Worthen.
Zeacrinus mucrospinus McChesney.
Locality. Weeping Water, Cedar Creek, and Rock Bulff.
Erisocrinus typus Meek and Worthen
Locality. Weeping Water. Cedar Creek, Nehawka, and Rock Bluff.
Ceriocrinus hemisphericus Shumard.
Locality. Louisville, Cedar Creek, and Nehawka.
Barycrinus subtumidus Meek and Worthen.
Locality. Louisville and Cedar Creek.
Scaphiocrinus hemisphericus Shumard.
Locality. Cedar Creek.

Vermes

Spirorbis sp.—See figure 7, pl. XII, and figure 4, pl. XIV.
Locality. South Bend.

EXPLANATION OF PLATE

Fig. 1. Zeacrinus mucrospinus
Fig. 2. Zeacrinus acanthophorus
Fig 3. Erisocrinus typus, plate of
Fig. 4. Same, larger specimen
Fig. 5. Eupachycrinus magister, plate of
Fig. 6. Scaphiocrinus hemisphericus, base of head, top view
Fig. 7. Same, bottom view.
Figs. 8 & 9. Erisocrinus, typus base of heads
Fig. 10. Barycrinus subtumidus (?)
All figures natural size
From specimens in the collections of Hon. Charles H. Morrill.



CRINOID HEADS, PLATES AND SPINES

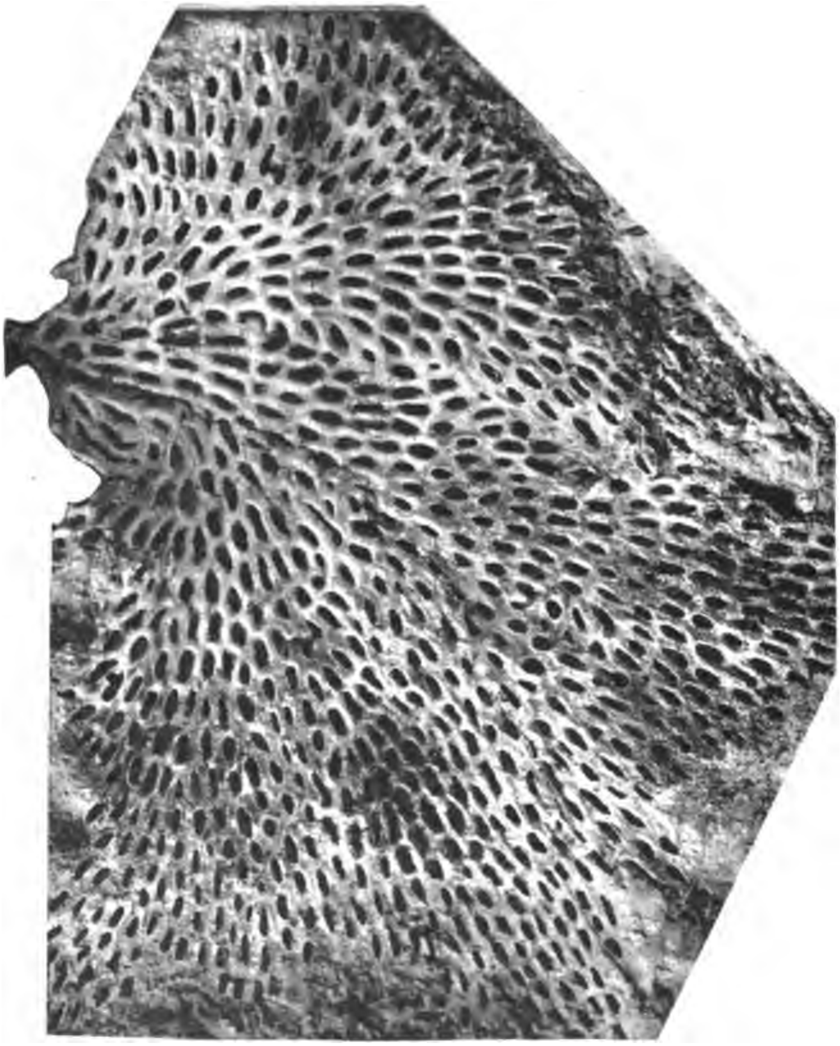
MOLLUSCOIDEA—THE BRYOZOA.

List of bryozoa collected and identified by Dr. G. E. Condra. For a complete treatment of the bryozoa see "Bryozoa of the Coal Measures of Nebraska" by G. E. Condra.

	South Bend	Louisville (below town)	Louisville (above town)	Cedar Creek	Plattsmouth	Rock Bluff	Weeping Water	Nehawka
Cystodictya anisopora Condra			X					
Fenestella conradi-compactillis							X	X
Fenestella kansasensis Rogers			X		X			
Fenestella mimica Ulrich					X			
Fenestella subrudis Condra							X	
Fenestella tenax Ulrich ?								X
Fistulopora carbonaria Ulrich	X	X	X	X	X		X	X
Fistulopora carbonaria-nebrascensis		X						
Pinnatopora pyriformipora Rogers					X			
Pinnatopora trilineata Meek					X			
Pinnatopora youngi Ulrich					X			
Polypora spinulifera Ulrich		X						X
Polypora submarginata Meek	X	X	X	X	X		X	X
Septopora biserialis nervata Ulrich		X			X			
Septopora cestriensis Prout					X			
Septopora decipiens Ulrich					X			
Septopora multipora Rogers		X						
Stenopora carbonaria (Worthen)		X						
Stenopora distans Condra		X						
Streblotrypa prisca (Gabb & Horn)			X		X			

EXPLANATION OF PLATE

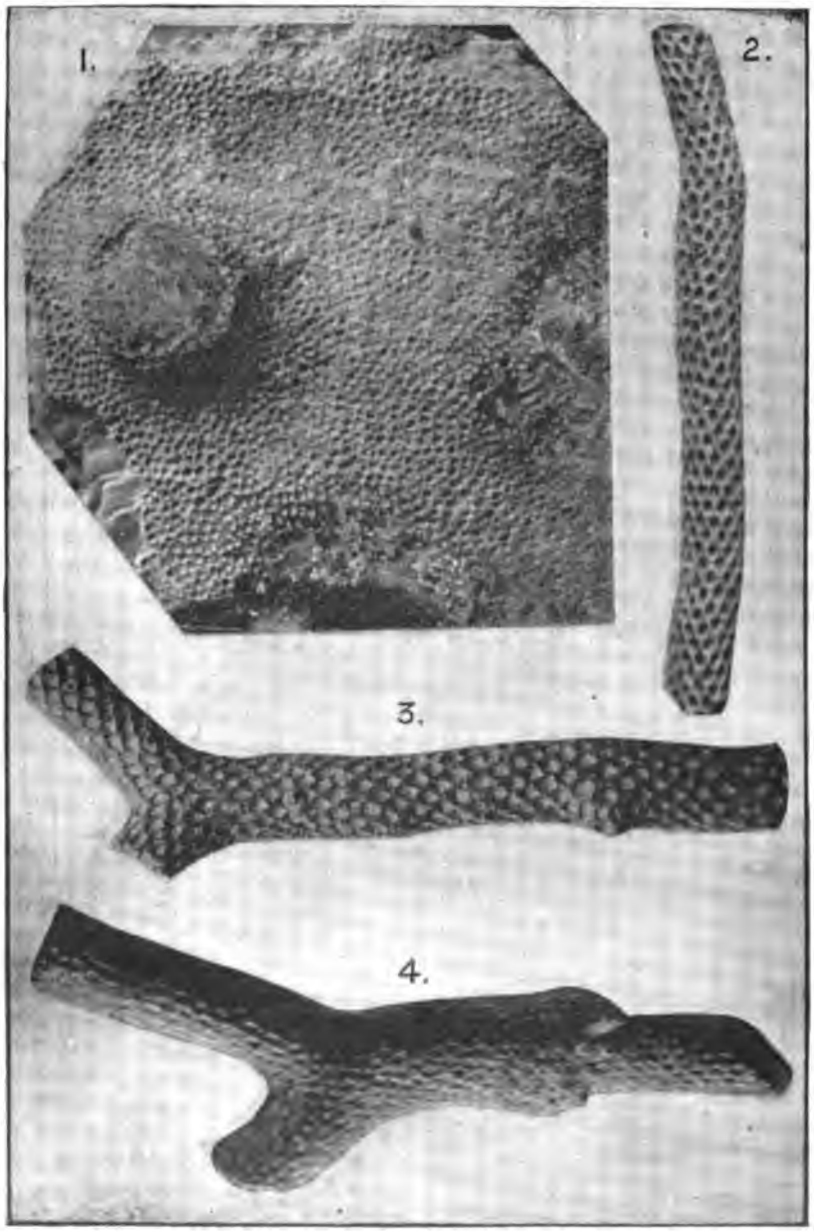
Polypora crassa, x 1¼
From collections of Hon. Charles H. Morrill



FAN BRYOZOA

EXPLANATION OF PLATE

Fig. 1. Stenopora (?) polyspinosa Condra, x 4½
Fig. 2. Rhombopora lepidodendroides Meek, young, x 6
Fig. 3. Ditto, x 6
Fig. 4. Ditto, showing inner and outer growth
From collections of Hon. Charles H. Morrill



BRANCHED BRYOZOA

Molluscoidea—The Brachiopoda

Productus semireticulatus Martin

In size these shells are slightly below the average of this species and are considerably distorted. Radiating and concentric lines are distinct.

Location. Weeping Water, Cedar Creek, and Nehawka.

Productus costatus de Konick.

Specimens, mostly distorted, of average size. Some of the shells collected contain concretions of chalcedony; others show iron stains probably from marcasite.

Location. Cedar Creek and Nehawka.

Productus cora d'Orbigny.

These specimens are typical, of medium size, and fairly well preserved.

Location. Weeping Water.

Productus cora americanus Swallow.

Only one specimen of this in the collection. Anterior fold distinct.

Location. Louisville.

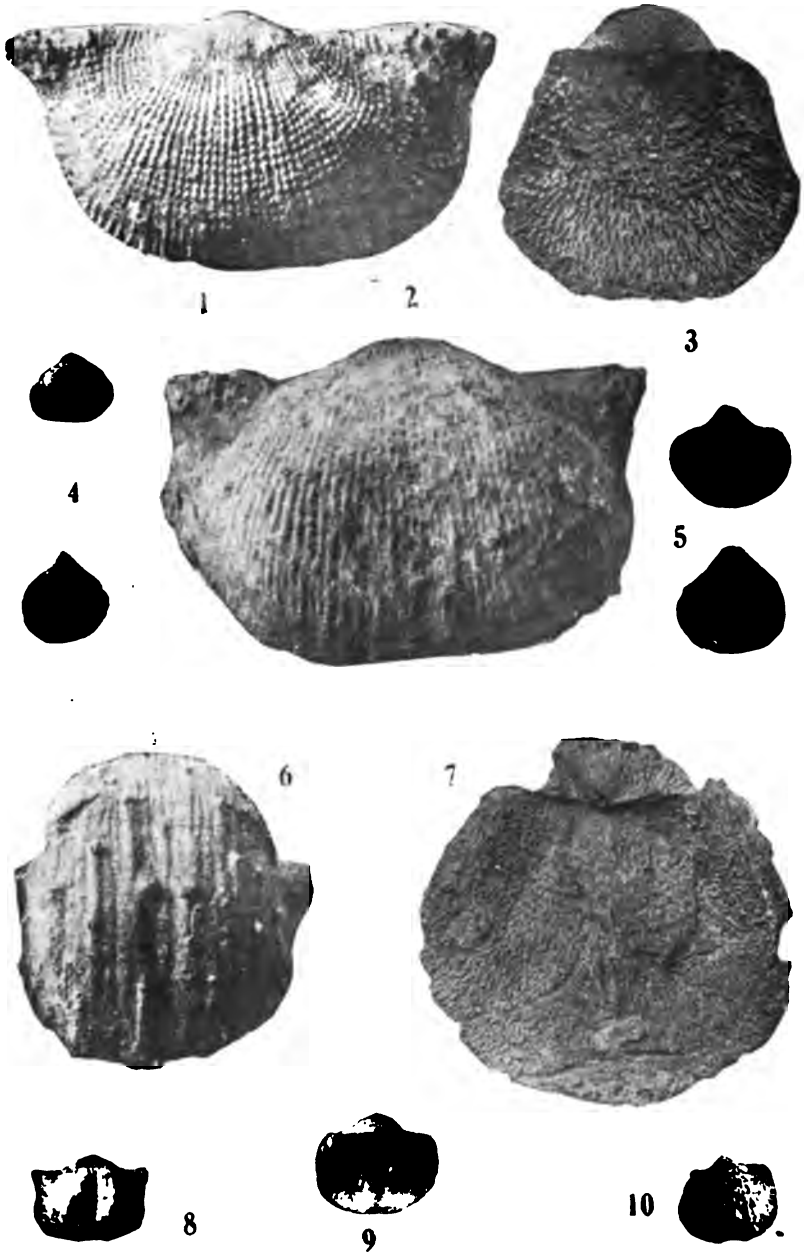
Productus nebrascensis Owen.

Shells of medium size. Some of these were collected from beds of soft material, hence both sets of spines are distinct. Dorsal valve very concave in some specimens. This is one of the most common of the Productidae in the region.

Locality. Weeping Water, Louisville, and Cedar Creek.

EXPLANATION OF PLATE.

Fig. 1. Productus semireticulatus, top view, view of apex.
Fig. 2. Same, from above.
Fig. 3. Productus nebrascensis.
Fig. 4. Rhipidomella pecosi.
Fig. 5. Ambocoelia planoconvexa.
Fig. 6. Productus co tatus.
Fig. 7. Productus symmetricus.
Fig. 8. Productus longispinus.
Fig. 9. Same, dorsal view.
Fig. 10. Productus pertenuis.
All figures natural size.
From the collections of Hon. Charles H. Morrill.



CARBONIFEROUS BRACHIOPODS

Productus punctatus Martin.

Specimens few and much below the typical in size. Surface markings distinct.

Locality. Weeping Water and Nehawka.

Productus sp.

Dorsal valves.

Locality. Louisville and Nehawka.

Productus longispinus Sowerby?

Specimens not abundant but well preserved. Short erect spines distinct. Care should be exercised in identifying this little shell that it is not confused with the young of some of the larger forms.

Locality. Weeping Water, Nehawka, and Rock Bluff.

Productus pertenuis Meek.

Excellent examples of the type but quite rare.

Locality. Weeping Water.

Productus symmetricus McChesney.

Some very imperfect and badly broken shells were found in one locality.

Location. Cedar Creek.

Entelletes hemiplicata Hall.

These fossils were very abundant in one of the quarries at Nehawka. Some were found in a massive bed, but they are more common in a shaly limestone beneath. This shell is readily distinguished by its oval outline and the sharp folds on the front part of the shell.

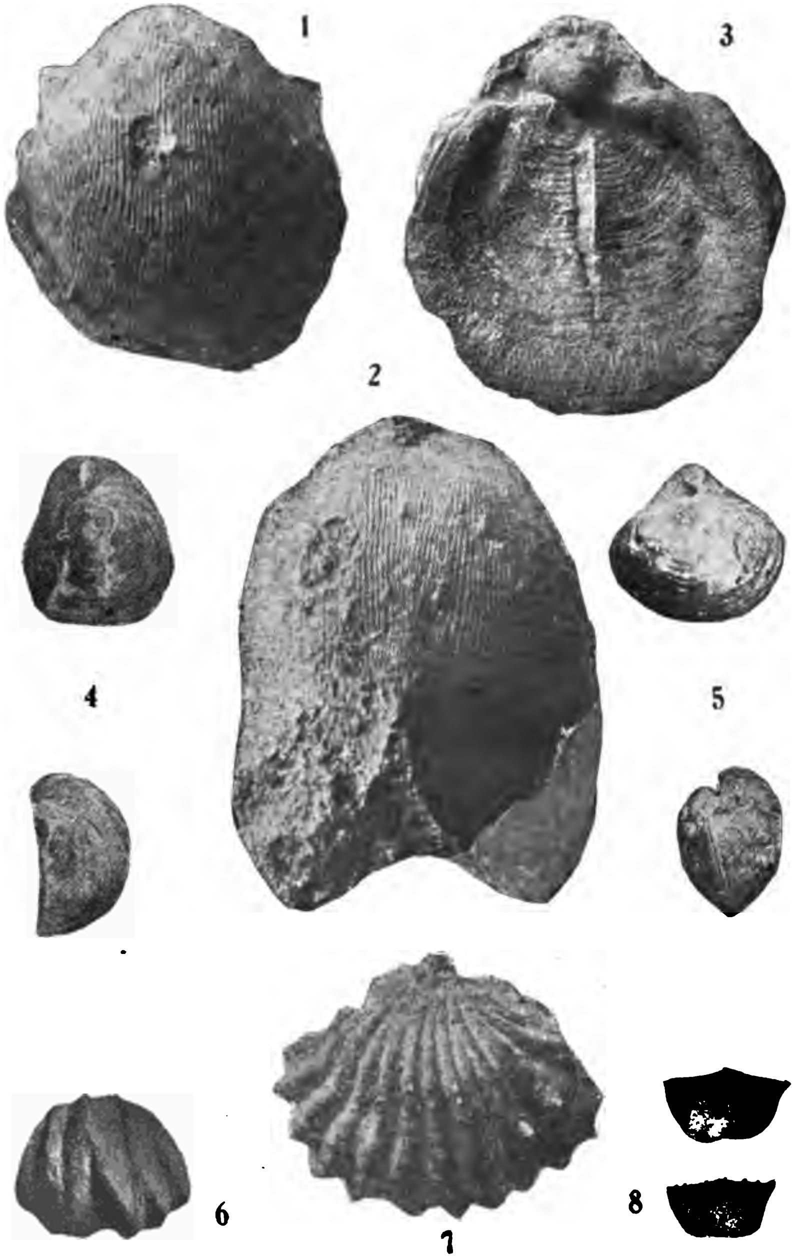
Locality. Weeping Water, Nehawka, and Rock Bluff.

EXPLANATION OF PLATE.

Fig. 1. Productus cora.
Fig. 2. Productus cora americana.
Fig. 3. Productus punctatus.
Fig. 4. Dielasma bovidens.
Fig. 5. Reticularia perplexa.
Fig. 6. Entelete hemiplicata.
Fig. 7. Mekeella striatocostata.
Fig. 8. Chonetes vernuilliana.

All figures natural size.

From the collections of Hon. Charles H. Morrill.



CARBONIFEROUS BRACHIOPODS

Pugnax utah Marcou.

This little shell is one of the most persistent and best preserved in the region. It varies greatly in size, but is generally small never exceeding one-half of an inch. The folds on the front part with the smooth portion near the beak render this shell easy of identification.

Locality. Weeping Water, Louisville, Nehawka and Rock Bluff.

Seminula argentea Shepard.

No exposure of any extent is found in this region where this fossil does not appear. It stands next to Fusulina secalica in persistence. Some of the shells show small concretions of chalcedony. Some have a portion of one valve removed, revealing the brachial windings within in a most excellent manner.

Locality. Louisville, Weeping Water, Cedar Creek, Nehawka and Rock Bluff.

Meekella striatocostata Cox.

These shells are mostly crushed and distorted. They may be readily identified by their beaks,, prominent costae and striations.

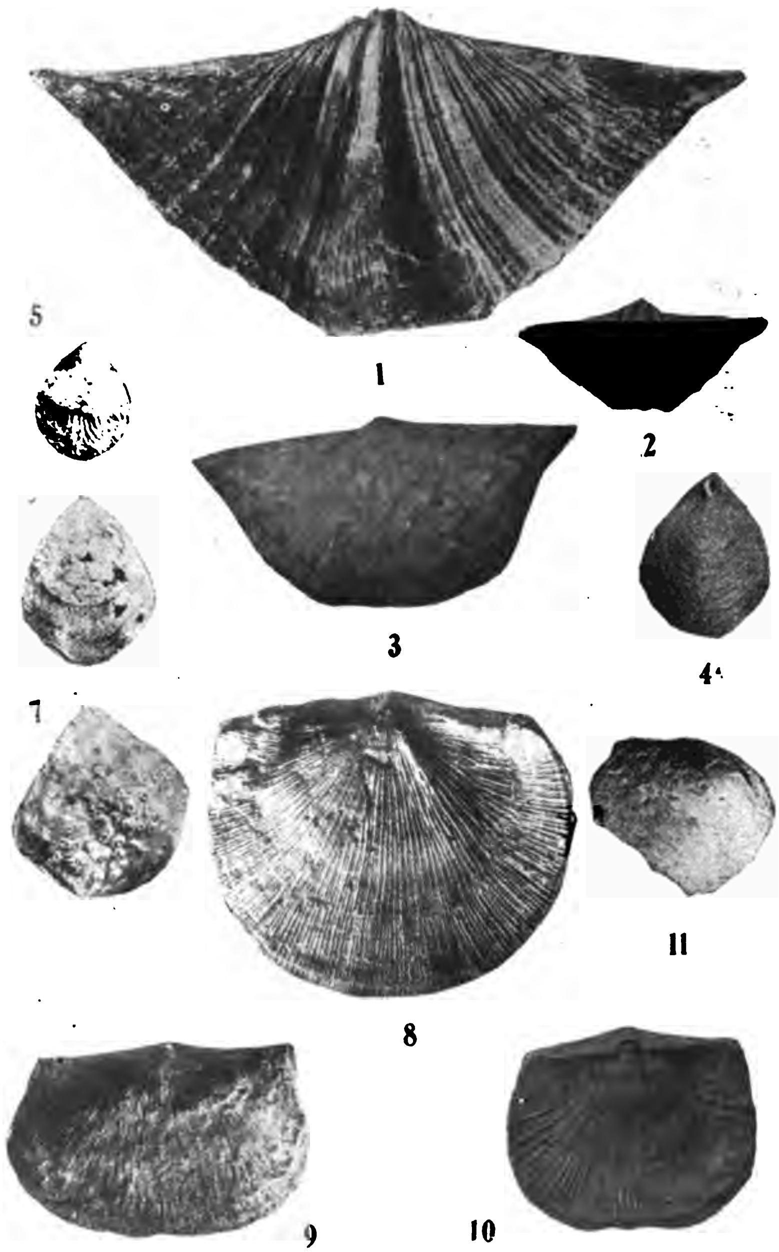
Locality. Weeping Water, Cedar Creek and Nehawka.

Orbiculoidea convexa.

Locality. South Bend.

EXPLANATION OF PLATE.

Fig. 1. Spirifer cameratus.
Fig. 2. Spiriferina cristata.
Fig. 3. Chonetes granulifer.
Fig. 4. Seminula argentea.
Fig. 5. Same, showing brachial coils.
Fig. 6. Same, showing chalcedony rings.
Fig. 7. Same, covered with Spirorbis shells.
Fig. 8. Derbya keokuk.
Fig. 9. Derbya bennetti.
Fig. 10. Derbya crassa.
1 1. Orbiculoidea convexa.
All figures natural size.
From specimens in the collections of Hon. Charles H. Morrill.



CARBONIFEROUS BRACHIOPODS

Dielasma bovidens Morton.

This shell is quite persistent throughout the region. Shells sufficiently perfect to show all of the characteristics are common. This shell should not be confused with Seminula argentea, which it somewhat resembles. To the ordinary observer its length and slender outline should serve as a distinction.

Locality. Weeping Water, Cedar Creek, Nehawka and Rock Bluff.

Chonetes granulifer Owen.

The types of this shell and verneuilianus described by Meek are from this locality, hence the description applies in toto. A small rock specimen, obtained from Rock Bluff, was covered by this shell, which must have been very abundant in that locality at one time.

Locality. Weeping Water, Cedar Creek, Louisville, Nehawka and Rock Bluff.

Chonetes verneuilianus Norwood and Pratten.

This shell with its long ears extending beyond the margin, its toothed hinge line, and its deep rounded median sinus, is easily distinguished from C. granulifer, the only shell of this region which it much resembles.

Locality. Weeping Water, Louisville, Cedar Creek, Nehawka.

Hustedea mormoni Marcou.

This small shell is very abundant. It is sometimes noted in the ledges, but the shell is such that it readily frees from the surrounding matrix, hence, it is found weathered out in large numbers in exposed places.

Locality. Weeping Water, Cedar Creek, Nehawka, and Rock Bluff.

Derbya crassa Meek and Hayden.

This is the fossil known to some of the quarrymen as "butterfly's wings," because of the slight convexity, the radiating costae, and the very thin valves, which the workmen have supposed to be the wings of butterflies preserved in the stone. Specimens common.

Locality. Weeping Water. Louisville, Cedar Creek, and Nehawka.

EXPLANATION OF PLATE

Hand specimen of Carboniferous limestone composed of Brachiopod shells, Chonetes granulifer, from Rock Bluff, Nebraska. Natural size. Collections of Hon. Charles H. Morrill.

ROCK COMPOSED OF CHONETES GRANULFER

Derbya bennetti Hall and Clarke.

Specimens few and imperfect. The collector will find difficulty in identifying this shell without a complete description or a type specimen.

Locality. Weeping Water and Nehawka.

Derbya keokuk Hall and Clarke.

Location. Weeping Water and Louisville.

Ambocoelia planoconvexa Shumard.

The weather readily frees this little shell from its matrix without injuring its form or surface markings.

Scores of good specimens are in our collection. It may be distinguished by the long, gently curved beak, extending over the hinge line and the small ventral valve.

Locality. Weeping Water, Cedar Creek, and Rock Bluff.

Reticularia perplexa McChesney.

These shells vary greatly in size, most of them are rather small. Only older shells show the crenulations distinctly. The surface makings are readily evident under an ordinary lens.

Locality. Weeping Water, Cedar Creek, Louisville, and Nehawka.

Rhipidomella pecosi Marcou.

In old specimens this fossil is quite robust; but it is often found crushed and flattened. Quite abundant.

Locality. Weeping Water, Louisville, Cedar Creek, and Nehawka.

Spirifer cameratus Morton.

This fossil persists throughout the area. In form it varies from those having attenuated ears to the very robust ones. It may be readily distinguished by the radiating costae extending to the end of the ears and by the distinct mesial fold.

Locality. Louisville, Cedar Creek, Weeping Water. Nehawka, and Rock Bluff.

Spiriferina cristata Schlotheim.

Like S. cameratus it varies greatly in form. Readily distinguished from small specimens of the former by the numerous lines of growth passing over the costae and by its much smaller size.

Locality. Weeping Water, Louisville, Cedar Creek, Nehawka, and Rock Bluff.

Mollusca.

Myalina recurvirostris Meek and Worthen.

This is one of the few shells which mark a distinct horizon. It was found in one of the beds in the Stout Quarry at Louisville and was one of the evidences used in correlating this bed with the bed containing the specimen in our Cullom section.

Locality. Cedar Creek and Cullom.

Myalina sp.

Fragments of Myalina are frequently found, but only occasionally are specimens sufficiently perfect for accurate specific determination.

Locality. Louisville and Cedar Creek.

Edmondia nebrascensis Meek.

Locality. Louisville.

Allorisma subcuneatum Meek.

One excellent specimen of this was found three miles east of Weeping Water. This measures, length 5.25 inches; height near the middle 2.25 inches; greatest convexity 1.75 inches.

Locality. Weeping Water, Cedar Creek, and Louisville.

Allorisma sp.

Internal Cast.

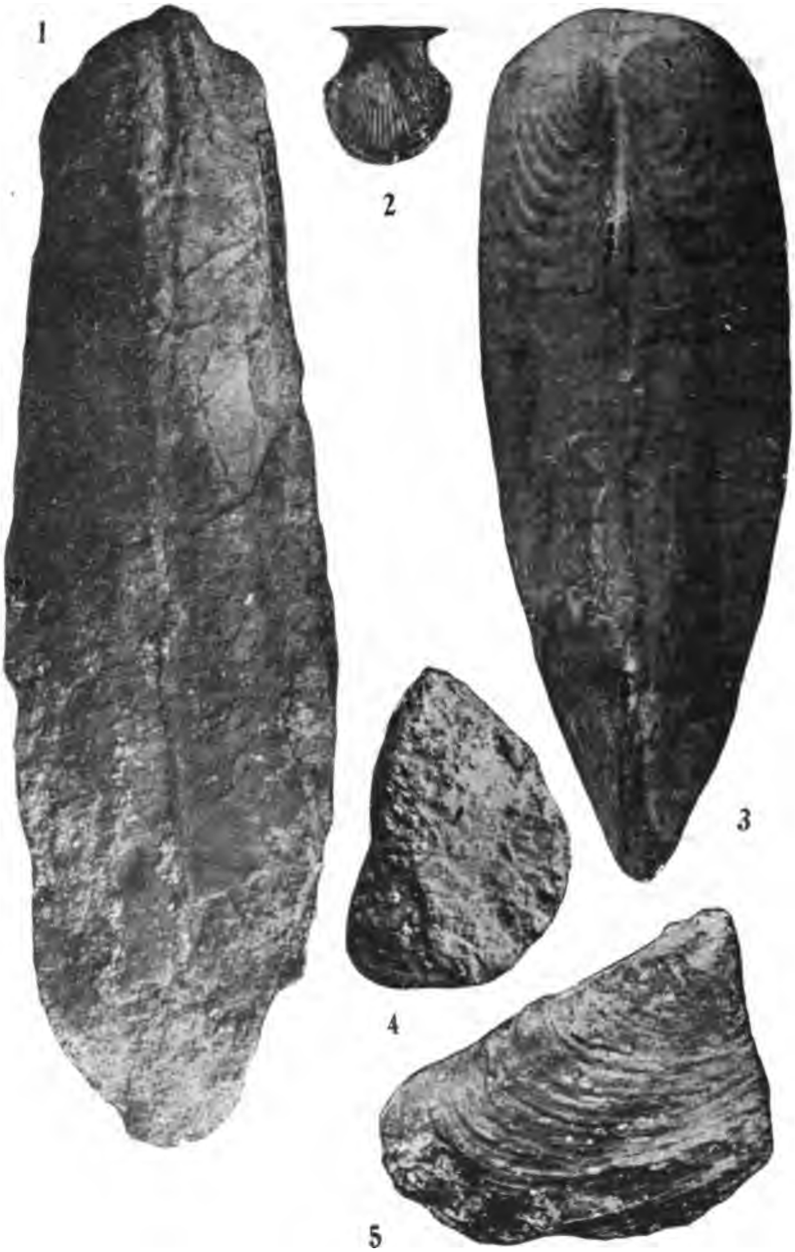
Locality. Louisville.

EXPLANATION OF PLATE.

Fig. 1. Pinna paracuta.
Fig. 2. Aviculopecten carboniferus.
Fig. 3. Allorisma subcuneatum.
Fig. 4. Myalina covered with shells of Spirorbis.
Fig. 5. Myalina recurvirostris.

All figures natural size.

From specimens in the collections of Hon. Charles H. Morrill.



CARBONIFEROUS MOLLUSKS

Aviculopecten carboniferus.

Very seldom are complete specimens found. The surface markings make identification certain.

Locality. Louisville, Nehawka, and Rock Bluff.

Pinna sp.

Only a portion of a cast.

Locality. Louisville.

Euomphalus rugosus Hall.

These shells are usually imbedded in a hard matrix from which they are freed with difficulty. The specimens found here are not so large as those found at other points in the state.

Locality. Cedar Creek and Nehawka.

Bellerophon bellus Keyes.

Some of these fossils are found in the extreme upper members of our series.

Locality. Weeping Water.

Bellerophon carbonarius Cox.

A few imperfect specimens were found.

Locality. Weeping Water.

Bellerophon giganteus Worthen.

But a single specimen of this was found. This shell is of typical size.

Locality. Weeping Water.

EXPLANATION OF PLATE.

A.

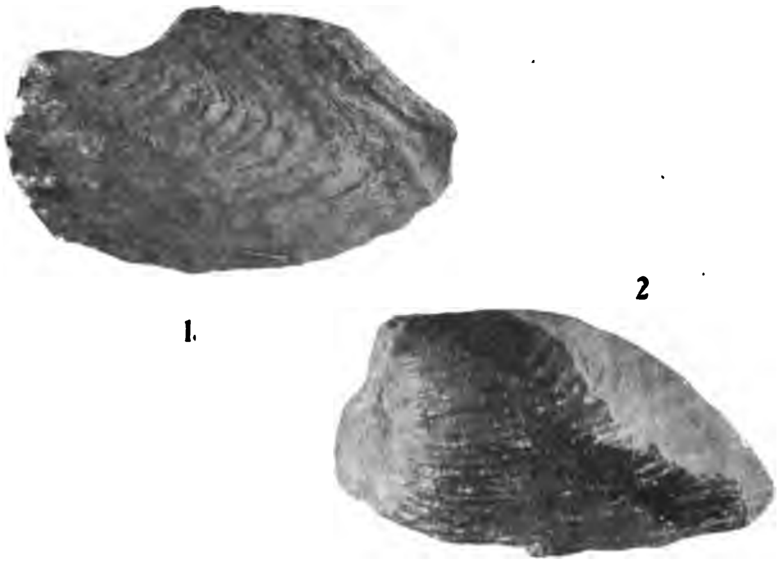
Fig. 1. Chaenomya minnehaha.
Fig. 2. Chaenomya sp.

B.

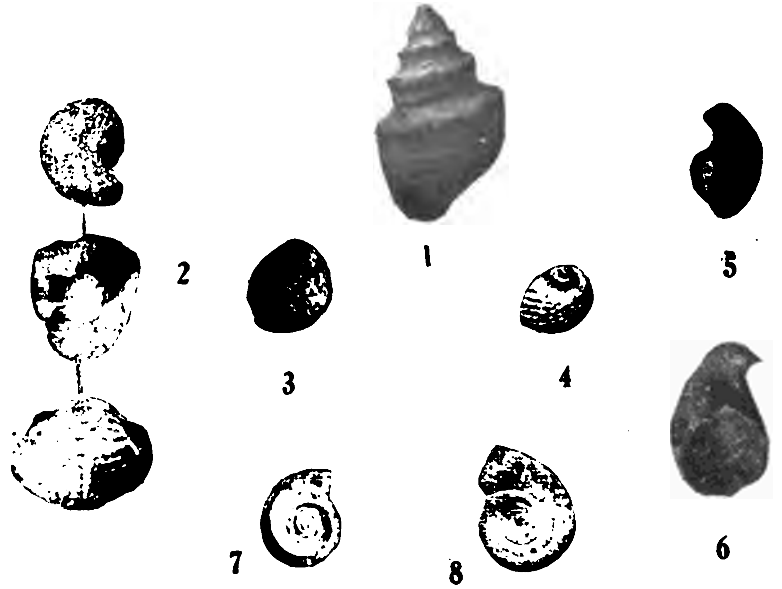
Fig. 1. Pleurotomaria perhumerosa.
Fig. 2. Bellerophon bellus, three views.
Fig. 3. Strophostylus remex.
Fig. 4. Trachydomia wheeleri.
Fig. 5. Capulus parvus.
Fig. 6. Same, larger specimen.
Fig. 7. Euomphalus rugosus.
Fig. 8. Same, larger specimen.

All figures natural size.

From specimens in the collections of Hon. Charles H. Morrill.



A—CARBONIFEROUS MOLLUSKS



B—CARBONIFEROUS GASTEROPODS

Pleurotomaria perhumerosa Meek.

A few quite perfect specimens of this little gasteropod were found.

Locality. Weeping Water and Louisville.

Trachydomia wheeleri Swallow.

One specimen.

Locality. Weeping Water.

Orthonychia cornuformis.

A number of similar shells remain for identification. These may prove to be the same genus but different species.

Locality. Cedar Creek.

Capulus sp.

Capulus parvus Swallow.

Locality. Weeping Water.

Dentalium sp.

Locality. Cedar Creek.

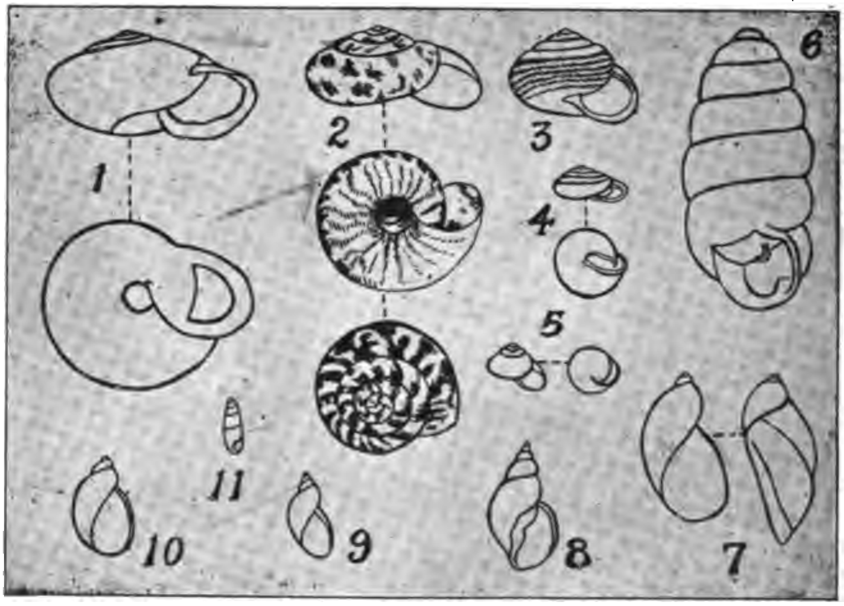
Orthoceras sp.

Locality. Nehawka.

Typical Loess Fossils

EXPLANATION OF PLATE

Fig. 1. Polygyra albolabris (Say) Pils.
Fig. 2. Pyramidula alternata (Say) Pils.
Fig. 3. Polygyra multilineata (Say) Pils.
Fig. 4. Polygyra monodon fraterna (Say) Pils.
Fig. 5. Helicina orbiculata Say
Fig. 6. Pupa muscorum Lin.
Fig. 7. Succinea ovalis Say
Fig. 8. Limnaea caperata Say
Fig. 9. Succinea avara Say
Fig. 10. Succinea grosvenorii Lea.
Fig. 11 Cochlicopa lubrica (Müll.)



FOSSIL SHELLS TYPICAL OF THE LOESS FORMATION

Arthropoda

Phillipsia major Shumard.
Locality. Cedar Creek, Louisville.

EXPLANATION OF PLATE.

Fig. 1. Phillipsia major.
Fig. 2. Same from Carboniferous of Missouri.
Fig. 3. Same, tail shield.
Fig. 4. Same, young, coiled.
All figures natural size.
From the collections of Hon. Charles H. Morrill.

1

2

3

4

CARBONIFEROUS TRILOBITES

Vertebrata

Campodus variabilis Newberry and Worthen.

Petolodus alleghaniensis Newberry and Worthen.

One of our specimens shows only the crown, but in an excellent state of preservation; the other is the entire tooth with a portion of the crown removed. Though we find no other trace of the animal the teeth are not especially rare.

Locality. Weeping Water and Cedar Creek.

Miscellaneous Fossils.

In addition to the list of fossils given above the following, unnoted by the author, were collected and identified by Miss Carrie A. Barbour, and are now in the Morrill Geological Collection at the University of Nebraska.

Echineodermata—Erisocrinus megalobrachius? Louisville.
" Eupachycrinus magister? Louisville

Vermes—Serpula sp. South Bend.

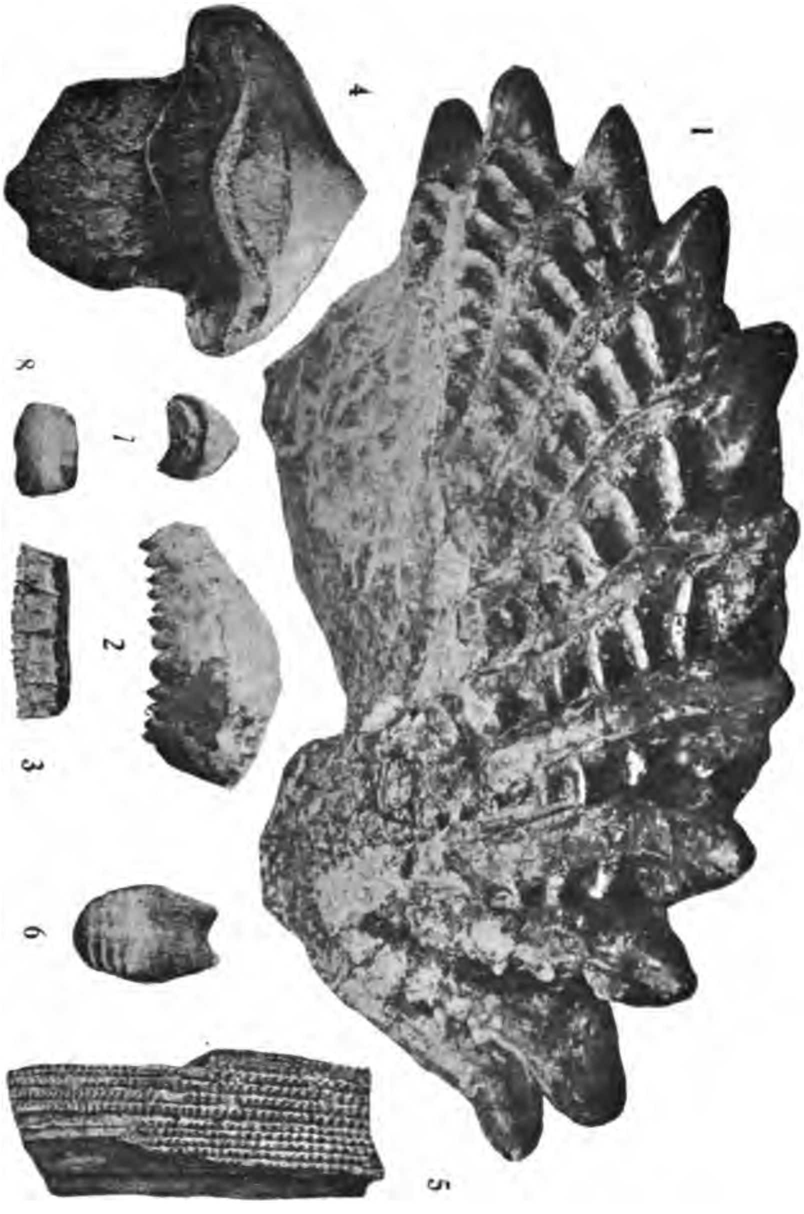
Brachiopoda—Orbiculoidea convexa. South Bend.

Lamellibranchiata—Sedgwickia topekaensis. South Bend.

Gasteropoda—Pleurotomaria missouriensis. Cedar Creek, South Bend, and Weeping Water.
" Orthonema subtaeniata. South Bend.
" Macrocheilus sp. Louisville.

EXPLANATION OF PLATE.

Fig. 1. Campodus variabilis.
Fig. 2. Same, young.
Fig. 3. Same young.
Fig. 4. Petalodus alleghaniensis.
Fig. 5. Ctenacanthus amblyziphias.
Fig. 6. Fissodus inequalis.
Fig. 7. Peripristis semicircularis.
Fig. 8. Janassa unguicula.
All figures natural size.
From specimens in the collections of Hon. Charles H. Morrill.

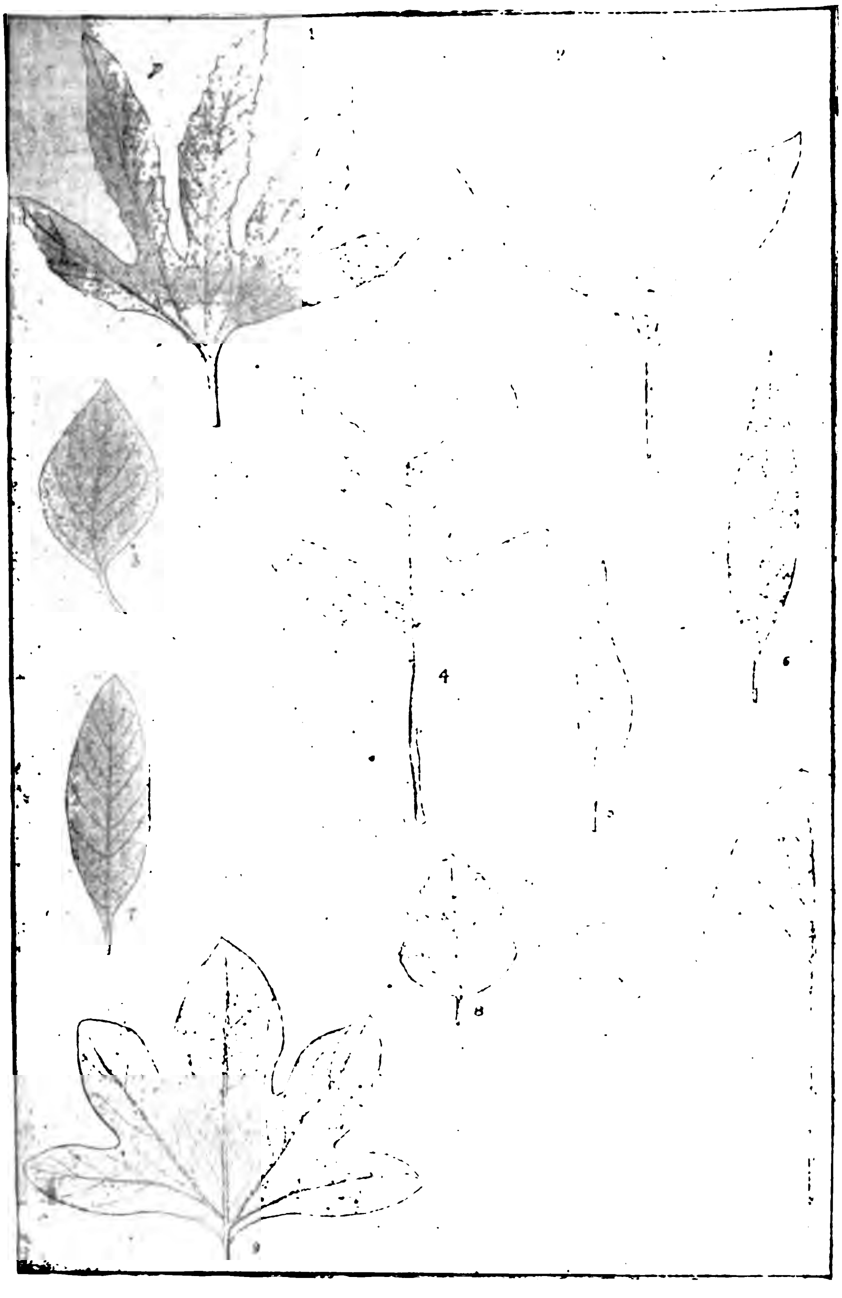


CARBONIFEROUS SHARKS' TEETH

Cephalopoda—Nautilus ferratus. Weeping Water.
" Pseudomonotis sp. South Bend.
" Pseudomonotis sp. South Bend. (This shell is different from above).
" Edmondia aspinwallensis. South Bend.
" Allorisma sinuata. South Bend.
" Allorisma granosa. Louisville.
" Chaenomya minnehaha.
" Chaenomya sp.
" Aviculopecten occidentalis. Louisville.
" Productus magnus. Louisville.
" Orthoceras cribrosum. Weeping Water.
Vertebrata—**Janassa unguicula sp. nov. Cedar Creek.**
" Fissodus inaequalis (St. J. & W.) Cedar Creek and
" Campodus variabilis (N. & W.) Cedar Creek and Louisville.
" Streblodus angustus Eastman South Bend.
" Peripristis semicircularis (N. & W.) South Bend and Louisville.
" Deltodus angularis N. & W. South Bend.
" Ctenacanthus amblyxiphias Cope. South Bend and Louisville.

EXPLANATION OF PLATE.

Fig. 1. Aralia wellingtoniana Lx.
Fig. 2. Sassafras cretaceum Ny.
Fig. 3. Populus kansaseana Lx.
Fig. 4. Liriodendron giganteum Lx.
Fig. 5. Salix proteaefolia Lx.
Fig. 6. Ficus proteoides Lx.
Fig. 7. Magnolia boulayanna Lx.
Fig. 8. Betulites westii var. latifolius Lx.
Fig. 9 Liquidamber integrifolius Lx.
Fig. 10. Aspidiophyllum trilobatum Lx.
From specimens in the collections of Hon. C. H. **Morrill.**



FOSSIL LEAVES CHARACTERISTIC OF THE SANDSTONE OF THE DAKOTA CRETACEOUS

ACKNOWLEDGMENT.

A pleasure remains to the writer. He wishes to acknowledge the kindness shown and assistance given by those who have been associated with him in the preparation of this paper. Professor Erwin H. Barbour has ever been ready with encouragement, assistance and direction. Dr. G. E. Condra, whose general knowledge of the territory is attested by former reports, has added materially to the subject matter. Appreciation is due Mr. C. A. Fisher, who was associated with the writer in the field for most of the actual mapping, and to Miss Carrie A. Barbour for assistance in collecting and classifying fossils. Thanks are due Miss Edith Webster, whose pencil has supplied the drawings, and whose brush added materially to the relief map. To many others who have kindly contributed information or assisted in a general way the writer is greatly indebted.

ERRATA.

Bottom of page 195, Plate 7, read plate XIX.
Page 198, omit the second line.
Page 198, foot note, Adden read Udden.
Page 224, Maynard, read Mynard.
Page 229, omit lines 26, 27.
Page 240, Loyd, read Lloyd.
Page 262, Fig. 8, read triserrata for triscererata
Page 270, Fig. 6, read Productus costatus
Page 272, Fig. 2, read americanus
Plate V, Fig. 2, multiplied two diameters.

NEBRASKA
GEOLOGICAL SURVEY

ERWIN HINCKLEY BARBOUR, STATE GEOLOGIST

VOLUME II
PART 3

NOTICE OF A NEW FOSSIL MAMMAL
FROM SIOUX COUNTY
NEBRASKA

BY
ERWIN HINCKLEY BARBOUR

LINCOLN, NEB.
WOODRUFF-COLLINS PTG. CO.
1905.

NOTICE OF A NEW FOSSIL MAMMAL FROM SIOUX COUNTY, NEBRASKA.

BY ERWIN HINCKLEY BARBOUR.

During the summer of 1905 the geological expeditions of the Hon. Charles H. Morrill of Lincoln were again resumed after a lapse of six or eight years. Owing to the over-crowded condition of the State Museum, coupled with unusual fire risks, Mr. Morrill withdrew his patronage, which had been so liberal since 1891.

Early in 1905 the State Legislature, pursuant to recommendations by Chancellor Andrews and the Board of Regents, voted the sum of fifty thousand dollars for the erection of a portion of the first wing of a new fireproof museum. Thereupon Mr. Morrill again offered substantial support to the amount of one thousand dollars annually for geological work. A party of students was organized and sent at once into the field to collect vertebrate fossils in the Daimonelix beds (Loup Fork) of Sioux county, at Agate, Nebraska, on the ranch of Mr. James Cook, which is an extensive one including some twelve miles along the Niobrara river.

As early as 1875 the bone beds of this region were recognized by Mr. James Cook. In 1892 they were visited by the writer, and collections were made by the Morrill geological expedition of that year. In the meantime every exposure of these beds throughout the entire region has been explored from year to year by Mr. Harold Cook. By him the specimen herein described was discovered, and for him it is named. Several discoveries were made during the season, but this one seems to outrank the others.

At first the skull and mandible were thought to constitute the known remains of this remarkable new fossil, but since this paper was begun it transpires that large blocks of material which had been taken out in connection with the skull, are literally packed with bones belonging to it. Though these bones are not sufficiently freed from the matrix to admit of description, yet it is now pos-

sible to state that there is enough of the skeleton in evidence to make a restoration of the animal possible. Awaiting the preparation of the various skeletal parts it seems to be in order to offer a brief description of the skull and mandible, accompanied by a half tone reproduction.

In general it may be stated that the skull, which is almost without break or blemish of any kind, is that of a primitive, "four-horned antelope" with wide orbits, tapering snout, and a well proportioned outline presaging a beast of grace and beauty equal to that of any living or extinct species.

The skull, which is that of an old animal, with sutures obliterated and teeth ground down, is decorated with four conspicuous horn cores, which in each case are grooved like those of the Bovidae. These horns constitute the first and most striking characteristic of the genus. The posterior or frontal pair curves upward and inward, while the anterior or maxillary pair curves upward and outward.

The writer would propose the name Syndyoceras for this genus, in allusion to the two pairs of horns. In addition to meaning two pairs sunduo in Greek has as a primary meaning two together, which is quite descriptive of the front horns, for they have fused and stand on a common trunk.

Next to the horn cores the most striking feature seems to be a nasal opening, of circular outline, just back of the anterior horns. The margins are roughened as though for ligamentous attachment, which suggests the possibility that it was functional. A parallel may be drawn here with Protoceras, in which, if the anterior horns or protuberances were enlarged, the nasal opening could easily be divided into two parts.

Another anatomical feature, interesting, though not unique, is found in the canine and first premolar on each side. The canine has migrated forward and has become incisiform functionally, while the first premolar has taken its place and has become caniniform in function.

SYNDYOCERAS COOKI, GEN. ET SP. NOV. x½.
Specimen No. 4-7-05 Geological Collections of Hon. Charles H. Morrill.

Dental formula: I. $\frac{0}{3}$, C. $\frac{1}{1}$, P. $\frac{3}{4}$, M. $\frac{3}{3}$.

Measurements of the skull: Length of skull 12¾ inches (325 mm).

Distance between the orbits across the frontals, 5 inches (128 mm).

Elevation of the anterior horn cores above plane of molars, 6½ inches (166 mm).

Spread of same at the summit, 8½ inches (216 mm).

Height of posterior horn cores above plane of molars, 7¾ inches (197 mm).

Spread of same at widest point, 10 inches (254 mm).

Width of palate between molars, 1¼ inches (32 mm).

The known skeletal parts of Syndyoceras are the following: Skull and mandible complete: vertebral series complete, as far as exposed, and articulated: pelvis and sacrum and both hind limbs complete and likewise articulated: several ribs, attached to their respective vertebrae above and to the sternum below, are in view; and a portion of one scapula. The fore limbs are apparently missing but will doubtless be found either in the material collected or else in the quarry. Each hind foot has two toes, and it now remains to find the fore foot to settle doubts as to whether it also had two toes, or two with a rudimentary pair of toes, or four functional toes, after the manner of the ancestral antelopes.

The cervical vertebrae are noticeably large and broad, but short. The horn cores are roughened and grooved as in the Bovidae, but the horns were no doubt very like those of our common prong-horn antelope, and were probably shed annually.

In size it was about intermediate between a common sheep and the antelope.

Approximate measurements of hind limb:

Length of femur, 8¾ inches (222 mm).

Diameter of shaft, ⅞ inch (24 mm).

Length of tibia, 9½ inches (242 mm).

Length of tarsus, about 2 inches (51 mm).

Length of metatarsus, 5 inches (128 mm).

Length of first phalanx, 1¾ inches (45 mm).

Length of second phalanx, ¾ inch (20 mm).

Length of ungual phalanx, 1⅛ inches (30 mm).

Height of sacral spines, above the acetabulum, about 4½ inches (115 mm).

According to these measurements, which are sufficiently exact for the present purpose, the hind quarters of the creature were between thirty and thirty-four inches in height.

The genus cannot be fully defined until more material and data are available. As to the affinities of Syndyoceras it seems to resemble Protoceras of the Oligocene more closely than any other known form, but the relationship seems remote. The antelope seems to be a related ally. For lack of full information it will be placed in the Protoceratidae, but further study will doubtless warrant assigning it to an entirely new family.

This adds another to the long list of fossils for which Nebraska has become famous in every center of learning, and now that the Morrill geological expeditions are again operative it is believed that many of these fine specimens which hitherto have been going to the eastern colleges and to European museums will begin to find a place in the museum of the state where they by right belong.

Before another year has passed a portion of the first wing of a new fireproof museum will be in readiness to receive and properly display all such specimens in the state collections.

The University of Nebraska, Sept. 1, 1905.

NEBRASKA
GEOLOGICAL SURVEY

ERWIN HINCKLEY BARBOUR, STATE GEOLOGIST

VOLUME II

PART 4

NOTICE OF A NEW FOSSIL RHINOCEROS

FROM SIOUX COUNTY

NEBRASKA

BY

ERWIN HINCKLEY BARBOUR

Scientific Contribution
Geological fund of Hon. Charles H. Morrill

LINCOLN, NEB.
WOODRUFF-COLLINS PTG. CO.
1906.

NOTICE OF A NEW FOSSIL RHINOCEROS FROM SIOUX COUNTY, NEBRASKA

DICERATHERIUM ARIKARENSE

BY ERWIN HINCKLEY BARBOUR.

The Rhinoceros is represented in Nebraska by a number of species, beginning with the hornless type at the bottom of the bad lands, and extending upward to the horned type of later deposits.

It is the purpose of this paper to announce the discovery of a new fossil Rhinoceros with a pair of horns on its snout.

This was found in the Loup Fork deposits (Miocene), on the ranch of Mr. James Cook, at Agate, Sioux county, Nebraska, by the geological expedition sent from the University of Nebraska by the Hon. Charles H. Morrill, of Lincoln, summer of 1905.

Diceratherium, in America, was established by Marsh in 1875 on material from the Miocene beds near the John Day river in eastern Oregon, and two species, armatum and nanum were recognized. A third species, advenum, was based on material from the Eocene (possibly Miocene) of Utah. Difference of horizon, and distance seem to warrant the specific name herein proposed. In comparing numerous individuals such variation was noted as to justify the belief that this group might legitimately enough be divided into several species.

Many skulls were found, but unfortunately no single one was complete. They were found in a very limited area, and together

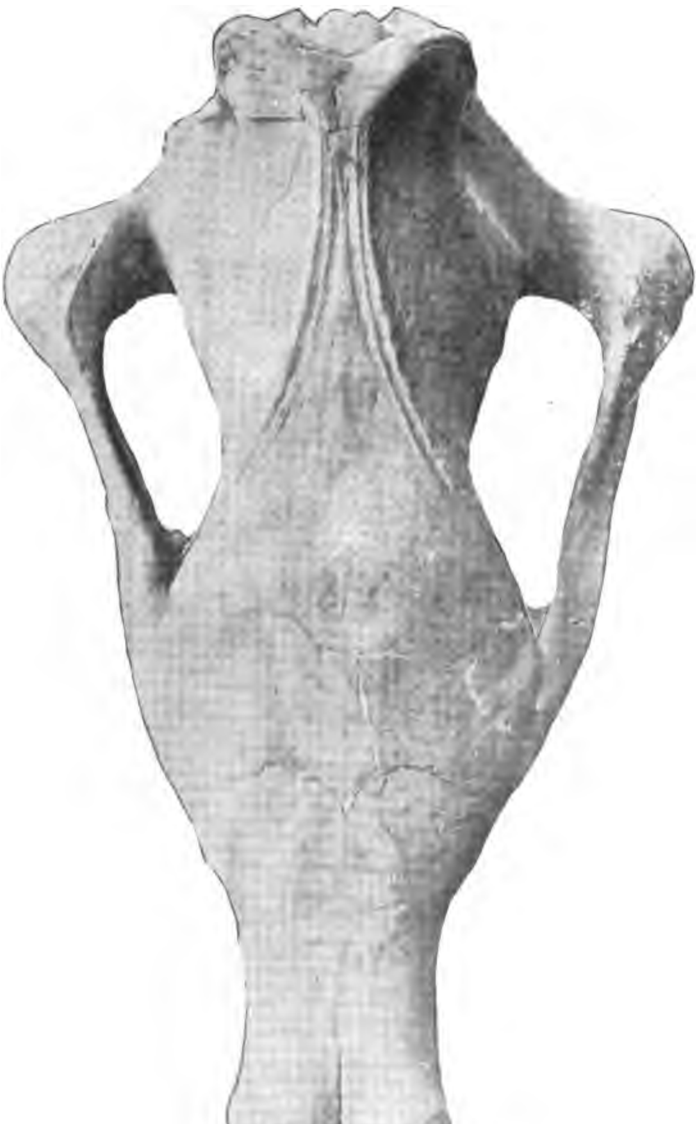


Fig. 1. Skull of Diceratherium arikarense, showing stout nasal horn cores, wide frontals, and pronounced temporal ridge 2-5 natural size. Top view of Fig. 2. From a specimen in the collections of Hon. Charles H. Morrill.

Fig. 2. Side view of a skull of Diceratherium arikarense, showing the tips of the nasals, the two nasal horn cores, the high occipital crest, occipital condyles, paroccipital process, squamous tuberosity, and a full set of maxillary teeth from another specimen, 2-5 natural size. From a specimen in the collections of Hon. Charles H. Morrill.

with them were great numbers of rhineroceros bones many of which presumably belonged to this genus, in which event a complete restoration is assured. The mandible is strong, and its angles are expanded and flare outward. The mandibular incisors, which are small, the crown being the shape and size of a pea, are worn but little, suggesting a rudimentary nature. Some crania are so short and saddle-shaped that they must belong properly to another species.

Two nasal horn cores constitute the most conspicuous feature of the genus. The cranium is thin, the occiput high and flaring, the condyles large and separated by a notch, and the zygomatic arches are thickened into a tuberosity at the angle.

The temporal ridges, which are double and very pronounced some times unite to form a sagittal crest, and sometimes are widely separated. There are so many intermediate stages that this feature may perhaps be considered a variation rather than a specific difference.

Dental formula: $I\ \frac{?}{1},\ C\ \frac{?}{0},\ P\ \frac{4}{3},\ M\ \frac{3}{3}$

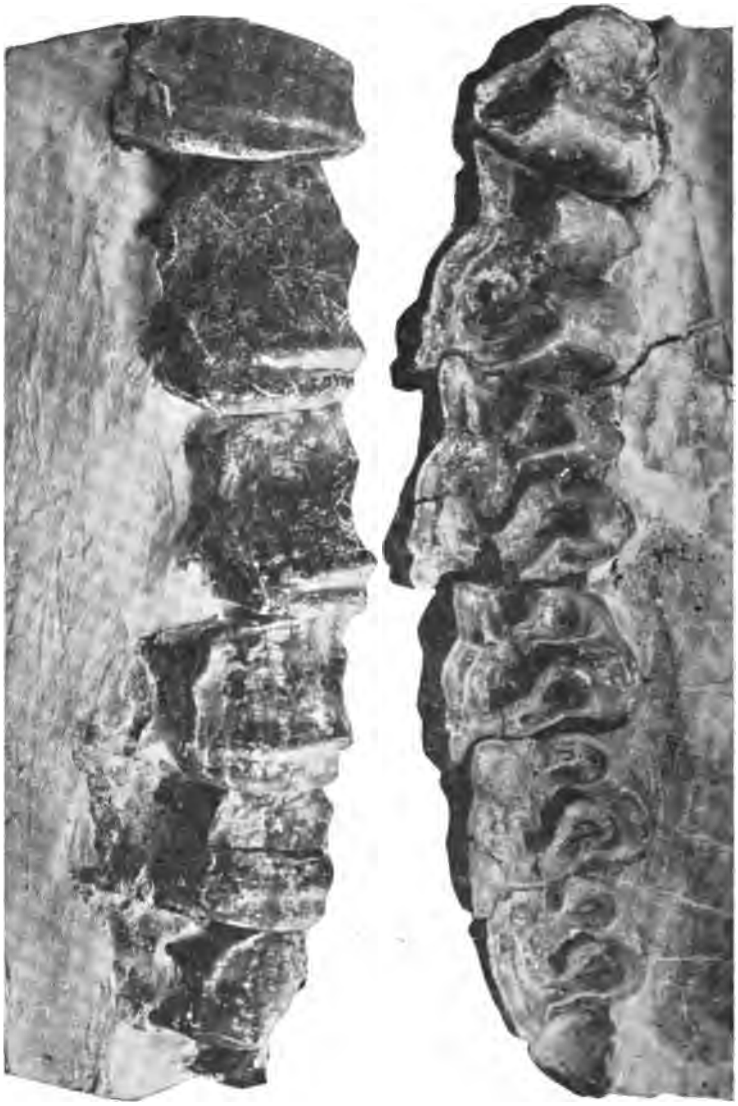
Diceratherium, Elothrieum, Moroprus, Syndyoceras, Oxydactylus, Daimonelix, a species of horse, tapir, rhinoceros, etc., being associated constitute an interesting new fauna for the region.

The specific name *arikarense* is proposed for this new Rhinoceros.

Measurements: — Length of skull, 14.75 inches (375 mm.); extreme width across cheek bones, (zygomatic arches) 8.75 inches (220 mm.); distance between post-orbital processes, 5 inches (130 mm.); width across horn cores, 2.75 inches (68 mm.). The brain cast is of good size, showing a brain well developed and convoluted.

In their day the carcasses of rhinoceros, giant hog, horse, and related forms must have drifted into coves, where their skeletons were deposited in heaps, constituting the bone beds, which are now quarried around Agate.

Work will be resumed in this region early in the summer, and many new facts will be obtained respecting this species. Citizens are again reminded that the fossil fields of Nebraska are famous; that the universities and museums of the world have for years been collecting and shipping our best material east to



A

B

Fig. 3. A. Maxillary teeth of Diceratherium arikarense, side view, etched by Daimonelix "fibers" B. Grinding surface showing four pre-molars and three molars, 5-6 natural size. From a specimen in the collections of Hon. Charles H. Morrill.

Fig. 5. Mandible of Diceratherium arikarense, showing three molars and three premolars, right side, ½ natural size. From a specimen in the collections of Hon Charles H. Morrill.

enrich other museums, and that, due to the generosity of Hon. Charles H. Morrill, liberal sums are now available with which to secure these excellent specimens for our own state collections.

The University of Nebraska,
June 15, 1906.

NEBRASKA
GEOLOGICAL SURVEY

ERWIN HINCKLEY BARBOUR, STATE GEOLOGIST

VOLUME II

PART 5

PRELIMINARY REPORT ON THE PRIMITIVE MAN OF NEBRASKA

BY
ERWIN HINCKLEY BARBOUR
AND HENRY BALDWIN WARD

Scientific Contribution
Geological fund of Hon. Charles H. Morrill

LINCOLN, NEB.
WOODRUFF-COLLINS PTG. CO
1906.

PRELIMINARY REPORT ON THE PRIMITIVE MAN OF NEBRASKA

BY ERWIN H. BARBOUR AND HENRY B. WARD

About ten miles north of Omaha, or three miles north of Florence, Nebraska, on a hill weathered out of the Loess formation, a circular burial mound was recently observed and explored by Mr. Robert F. Gilder.

Many skeletal parts and eight skulls have already been exposed and as the work of excavating progresses other remains will doubtless be added to the list.

The bones were unearthed early in October, the entire collection donated at once to the State Musuem, and the skulls were figured and described by the discoverer in the World-Herald, October 21.

Five of the skulls were found at a depth of four to five feet, in a layer of "packed clay" or loess. These seem to be of such a primitive order that they are worthy of special study, and it is possible that they may prove to be the earliest type of man known as yet in America. Above this layer three skulls and many bones of a more advanced race have been found, and it is certain they were buried intrusively. It is not an uncommon thing for one tribe to bury its dead in or about the mounds of predecessors.

It is not improbable then that the three skulls in the upper layer are those of mound builders while those below are their progenitors.

This paper will concern itself with the remains found in the lower layer.

It is plain that burial of the dead was not immediate, for the bones seem to have been weathered, scattered, and gnawed prior to final interment. The relative scarcity of ribs and of bones of the foot and hand, and the position of parts go to indicate the same thing.

The fine state of preservation of these bones, which at the least must be very old, is due to the fact that the rainfall of the region is light, and most of the storm water would flow immediately from the knob of the hill, and the little that soaked in would percolate

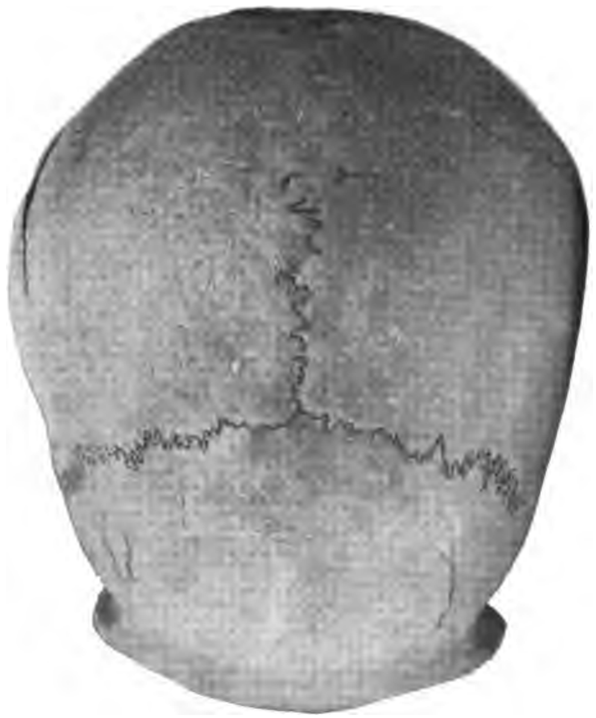


Fig. 1. Skull No. 6, Nebraska Man, top view, showing thick prominent superciliary ridges, frontal bone without eminences, right and left parietal, and interparietal or os incae at the back. The fronto-parietal, interparietal and occipital sutures are deeply dentate. One-half natural size.

Specimen No. 6-1-11-06. The Robert F. Gilder collection, State Museum.

Negative No. 9-1-11-06. Hon. Charles H. Morrill's collection of geological photographs.

rapidly through the permeable soil, and would leach the bones but little.

The limb bones are massive and large, indicating a stature of six feet, and uncommonly rough, indicating a people who were very muscular, particularly in the lower extremities. The strikingly large protuberances support this view. The crania are low-browed with heavy protruding superciliary ridges, and receding foreheads which lack frontal eminences. In life these people had flat heads, protruding muzzles, large chins, and heavy brows, shading eyes deep set and close together. The low-browed crania are not the result of head-binding, nor are they those of idiots, nor are they malformed. Instead they are normal, and represent the cranial development of the time. Though showing many points of similarity as well as differences, on the whole they seem inferior to the mound builder, and we may for the present at least consider the Nebraska Man as a very early or degenerate mound builder. In corroboration are the crude flint implements or chips, whichever they are, associated with the bones, and the mode of burial in mounds.

After carefully comparing these skulls with known skulls in his collection, Dr. M. H. Everett, who has studied the mound builder in various states, pronounces the five skulls as being at least as ancient as the mound builder, which he takes them to be.

Several bones were deeply gnawed by rodents, one or more appear to have been hacked or scraped by some flint blade, and a couple are interesting pathologically. One of these is a broken ulna which had knit together without surgical aid, and the other is a case of exostosis between two lumbar vertebrae, which have become co-ossified. A stellate fracture of the skull near the temple tells of a tragedy and the roughened surface beneath and around the fracture indicates the subsequent inflammatory abscess and a lingering death. The two sacra show peculiarities, interesting though not unique, the one having a neural arch over vertebrae one, two, and three; the other having no neural arch throughout the five co-ossified vertebrae. There are peculiarities and variations in the individual bones which ought to be noted, but such detailed considerations belong properly to a more

Fig. 2. Skull No. 6. Nebraska Man, front view, showing thick protruding superciliary ridges, frontal bone without eminences, right and left parietals. Fronto-parietal and interparietal sutures deeply dentate. Three-fifths natural size.

Specimen No. 6-1-11-06. The Robert F. Gilder collection, State Museum.

Negative No. 10.5-1-11-06. Hon. Charles H. Morrill's collection of geological photographs.

technical paper, and only the more salient points need consideration here.

THE SKULL

The skull is characterized by narrowness through the temples, by thick protruding superciliary ridges or brows, by a low, retreating forehead as destitute of frontal eminences as Neanderthal man, by a well expanded parietal region with parietal eminences, and very faint temporal ridges, and by a flattened occipital region, deeply scarred for muscular attachment. The skull wall seems distinctly thicker than that of modern man. Unfortunately, in each case, the base of the skull is very fragmentary or wanting, which makes it the more difficult to get exact measurements and angles, and impossible perhaps to get more than a fair approximate measure of the cranial cubic contents. It seems wiser to leave these measurements for the final report after all possible fragments have been put together. Maxillae and premaxillae are at hand, and can be placed in about the proper position in the skull. Posteriorly one skull shows a fine interparietal bone or os incae, as often called.

THE MANDIBLE

The mandible compares well with that of a modern European in size and in form, but it is noticeably thicker and heavier. The mental process is bold and well pronounced like that of civilized man. The canines scarcely exceed the incisors in strength. The molars are about of ordinary size but the manner in which they are worn, as evidenced by the several jaws, is reversed, the first molar being worn but little, the second considerably, and the third worn down to the gum, indicating that they had been accustomed to the mastication of coarse hard food.

MISCELLANEOUS BONES

The ribs, vertebrae, bones of the digits, hand bones, sesamoids, etc., show no differences sufficiently marked to warrant description here. The arm bones give the impression of being a trifle light, while the leg bones seem to be a trifle heavy, rough and angular. The femur seems above average in strength and in roughness for muscular attachment, both in the trochanters and muscular ridge. The impression for the ligamentum teres is large deep and elliptical in outline with a surrounding ridge. The femur

Fig. 3. Skull No. 6. Nebraska Man, side view, showing thick protruding superciliary ridges, retreating frontal without eminences, parietal, interparietal (os incae, os wormianum), occipital and a portion of the temporal bone with mastoid process and external auditory meatus. One-half natural size; right side reversed to face left.

Specimen No. 6-1-11-06. The Robert F. Gilder collection, State Museun.

Negative No. 19.5-1-11-06. Hon. Charles H. Morrill's collection of geological photographs.

shows a strong forward curvature and is triangular in cross section with the depth much greater than its breadth. The knee is very broad and flat; the tibia is also triangular in section and much deeper than broad. The character of the limb bones agree well with the more primitive types.

The writers have frequently seen examples equally ancient but these are the first authentically located.

In succeeding reports the peculiarities of individual bones will be considered.

Associated with the skeletons were certain flint implements or chips of crude design.

MEASUREMENTS

The antero-posterior diameter of skull No. 6 is 181 mm., its transverse diameter is 145 mm., while the maximum and minimum frontal diameters are 93 and 114 mm. respectively. As the right side is broken the circumference can only be estimated; it is not far from 500 mm. and the height of the skull, approximated for the same reason, measures about 125 mm. The cephalic index calculated on the basis of these data is 79. After the mass of fragmentary material has been completely assorted, it is hoped that some further portions of the skull may be found and then the measurements above will be more exactly determinable.

BRIEF GEOLOGICAL DESCRIPTION

While this paper was in press the senior writer visited the mound in company with Mr. Gilder and undertook critical investigation. The mound is situated on the summit of a hill of loess 200 feet above the Missouri river.

A geological section from the Missouri valley to Gilder's mound on the summit of Long's hill is as follows: dark carboniferous shale, overlaid by fifteen or twenty feet of glacial clay, on which rests 150 feet of homogeneous light buff loess. The three skulls buried intrusively were in a mixture of black soil and buff subsoil. The five primitive skulls and certain bones were fragmentary,

Fig. 4. Skull No. 6, Nebraska Man, back view, showing parietals, interparietal (os incae or os wormianum), occipital and right temporal with mastoid process. Sutures deeply dentate. One-half natural size.

Specimen No. 6-1-11-06. The Robert F. Gilder collection. State Musieum.

Negative No. 18.5-1-11-06. Hon. Charles H. Morrill's collection of geological photographs.

water-worn and scattered through four or more vertical feet of original undisturbed loess, and plainly belong to that formation, as will be discussed at length in succeeding papers.

The bones of the lower layer seem synchronous with the loess formation, and antedate the hill itself, while those of the upper layer are younger than the loess and subsequent to the hill.

The occurrence of the two sets of bones at this spot seems to be purely accidental.

October 26, 1906.

Issued and distributed December 22, 1906.

NEBRASKA GEOLOGICAL SURVEY

ERWIN HINCKLEY BARBOUR, STATE GEOLOGIST

VOLUME II

PART 6

EVIDENCE OF LOESS MAN IN NEBRASKA

BY

ERWIN HINCKLEY BARBOUR

Scientific Contribution

Geological fund of Hon. Charles H. Morrill

LINCOLN, NEB.

WOODRUFF-COLLINS PTG. CO

1907.

EVIDENCE OF LOESS MAN IN NEBRASKA

BY ERWIN HINCKLEY BARBOUR

Unconsciously or otherwise an investigator is often influenced to see that which seems confirmatory rather than that which is contradictory to his conceptions and beliefs.

But in conducting the search for evidence of human remains in the pleistocene the writer has striven against this psychological tendency and has aimed to be severely critical and exact.

After continued investigation he stands ready to give notice of the occurrence of human remains in the loess, and unhesitatingly and unconditionally announces his belief in the discovery of Nebraska Loess Man.

Mention of this fact has already been made in a preliminary report of the Nebraska Geological survey, Vol. II, part 5, pages 319-327, recently published. Such importance attaches to the discovery as to warrant a paper devoted to the geological facts connected therewith.

PHYSIOGRAPHIC FEATURES

North of Omaha for a number of miles the topographic features are bold and abrupt for a prairie country, due to the proximity

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Fig 1. A scene in the Missouri river valley looking north. Long's hill, a hill of loess, rises 150 feet above the immediate valley. Gilder's mound is directly under the point o.

of the Missouri river. It is but a few years since that river was intrenching its banks and cutting precipitous bluffs in the vicinity

of Florence. The bold river wall is dissected by numerous tributary streams and thus are formed many rugged hills having a relief of 150 to 200 feet.

The steep slopes are grown over with second-growth timber, the first crop having been cut for use in the construction of the Union Pacific railway.

On all sides many and even extensive landslides are in evidence and must be reckoned with in all field work.

In October, 1906, Mr. Robert F. Gilder, of Omaha, who for several years has been investigating the region around Omaha and

Fig. 2. A section south of Pries lake near Long's hill. The roadway is just at the top of the carboniferous. The student's head is at the top of the Kansan drift, which attains a thickness of forty feet at the telegraph pole.

Above the drift lies loess of varying thickness showing characteristic columnar structure. Valley of the Missouri river to the left. Neg. 2–30-11-06.

Council Bluffs, opened a mound on the Missouri river front ten miles north of Omaha or three miles north of Florence, Douglas county, Nebraska, which yielded unique remains.

From Florence north to Long's hill there is a continuous section along the roadside for about three miles, and from the base of Long's hill to the summit, on which Gilder's mound is situated, there is an unbroken section, hence the geology of the place is well exposed, and being simple is easily interpreted.

The public highway, which is about forty feet above the river level, is just upon the carboniferous, and its dark carbonaceous shales constitute a distinct geological feature. Upon the shale rests an average of ten to fifteen feet of glacial drift containing Sioux quartzite and granitic boulders. Upon the drift comes 150 feet of bright buff loess such as is conspicuous in and around Omaha and Council Bluffs.

A road leads from the base to the summit of Long's hill by a rather steep grade, and incident to the wear of travel and guttering by rain the road bed has been lowered rapidly and runs in a sort of canyon with inclosing walls ten to twelve feet high, constituting a section from base to top. It is a hill of erosion, and no discoverable land slip has complicated its simple geology. The

Fig. 3. The road runs between loess walls from base to summit of Long's hill, thus making a continuous section to Gilder's mound. Negative No. 7–30–11–06, Geological Expedition of Hon. Charles Morrill, 1906.

summit of the hill, as measured by a surveying aneroid, is 200 feet above the river level and about 150 above the valley out of which it rises. The hill is conical, and its apex would naturally be chosen by the mound builder as a sightly spot for burial. Further than this there is no discoverable relation between certain human remains found in the upper layer and those in the lower.

Here in October were found two mound builder skulls, and below them parts of eight skulls and many bones of a still more primitive type. The writer at once joined the discoverer, Mr. Gilder, in a critical investigation of the place, continuing work from time to time to December 2nd, 1906.

Two of the skulls found at this spot are mound builders' in all probability. Together with them was the skull of a young child differing from the others in color, texture, and thinness of skull wall It is presumably that of a modern Indian buried intrusively in the sepulchre of predecessors. These were found in the upper layer readily discernible as a mixture of black soil and light buff subsoil such as would result from digging and burying. This layer has a thickness of two and a half feet. Below

Fig. 4. A snap shot photograph of Mr. Robert F. Gilder taken unawares in the east trench of his mound on Long's hill, ten miles north of Omaha. Negative No. 3–8–11–06, Hon. Charles H. Morrill's collection of Geological Photographs, the University of Nebraska.

it was a distinct undisturbed layer of unmistakable loess, and in it to a depth of twelve feet were many fragments of human bones, loess shells, and stray angular pebbles.

In brief the conclusion is that, in the case of the upper bone layer there was burial, in the lower deposition. Those in the loess doubtless antedate the hill itself, while those in the upper layer are subsequent to it. That archaic burial could have taken place in loess without detection is altogether improbable. Of

necessity there would result a mixture of black with light soil and a breaking up of the lithologic structure, which certainly would be detected. The loess structure and color is perfectly preserved, and there are present the vertical lime tubes, concretions and shells characteristic of the loess precisely as is customary. Out of the evidence at hand the writer concludes that the bones of this layer are strictly synchronous with the loess formation in which they occur, in substantiation of which comes the fragmental nature of all bones, their water-worn condition, their wide range of distribution, and disasssociation of parts.

One would scarcely think of such conditions being possible in the

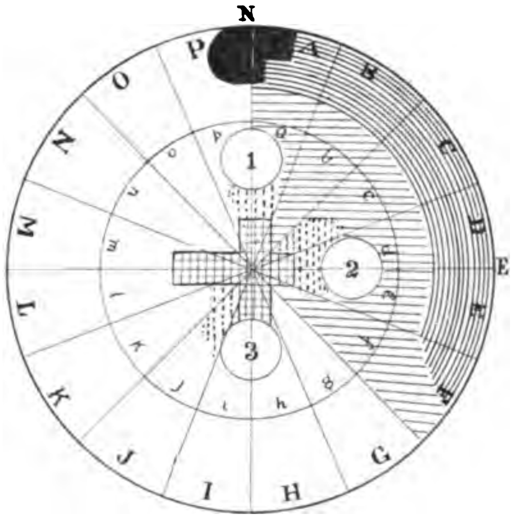

Fig. 5. Ground plan of excavation at Gilder's mound. Cross lines represent Mr. Gilder's original cross trenches; the broken lines extensions made November 8; 1, 2, 3, shafts sunk November 16, to a depth of 8 feet; horizontal lines, excavations November 29 to December 1, average depth, 6 feet; concentric lines, depth of 8 to 9 feet; black area, depth 12½ feet; the inner circle, which is the mound, is 18 feet in diameter; the outer one 30 feet.

case of human burial, besides it is improbable that a primitive race would dig graves to the depth of twelve feet. Should a people without tools and appliances perform such an improbable feat, would they bury water-worn fragments, and would they scatter

them so widely as not to exceed five or six bits to the cubic yard? How could they replace the earth in the grave in such order and regularity that there would be perfect gradation of structure and color from soil to subsoil? Evidence of pleistocene man in America has been accumulating for years, and the verification of his existence has been expected. This may in fact be the verification.

Fig. 6. Mandible of a youth found in section j, near 3, at a depth of 4½ feet. The teeth seem to have been lost in the process of deposition. Specimen No. 3–8–11–06, the Gilder collection, the University of Nebraska. Negative No. 18–3–1–07, the Morrill collection of Geological Photographs.

Respecting the antiquity of the remains the chief evidence paleontologically must be derived from the skulls, which seem to be of the Neanderthal type. Evidences from other skeletal parts are subject to error owing to the wide range of variation in human bones. The association of loess fossils is significant, and when even a remnant of any extinct species is found it will be final.

No sign of stratification, which would be valuable evidence, can be reported.

HISTORY AND METHOD OF INVESTIGATION

Early in November the writer extended Mr. Gilder's transverse trenches, and quickly discovered that one set of skulls found in the upper layer had been buried, while a second set lower down had not. This discovery seemed important and extreme care was exercised in all succeeding work.

Human bones, scattered, water-worn, fragmentary, and unrelated, were found on this occasion in natural undisturbed loess at all levels down to six feet.

The set of bones and fragments then collected is catalogued in the State Museum, the University of Nebraska, under No. 8-11-06.

The most interesting single bit was the left half of a frontal bone secured at a depth of four to five feet. Later, at a distance

Fig. 7. Water-worn fragment of human bone found in undisturbed loess at a depth of 4 to 5 feet at A, see Fig. 5.

of five feet, the other half was dug up, and the two parts fit, completing an interesting frontal. At a depth of five feet was dug out a scapula which differs from the average form.

The acromion is not deflected, but in line with the spine, which is strong, broad and continuous without constriction to the internal scapular border. A jaw which was found in undisturbed loess at a depth of four feet was that of a youth. The crowns of the teeth were scarcely worn, so old age cannot be assigned as the reason for the absence of all the teeth save molars No. 2 and 3 in the right half and No. 2 in the left. See Fig. 6

Just as the teeth of any water-soaked skull or jaw drop out readily, so it seems to have been with this one.

The teeth must have been lost in the process of deposition, for we must pronounce this deposition and not burial.

The above mentioned frontal, scapula, and jaw, being the first material found in the loess, may be subject to error in observation but they at least served to stimulate accuracy in succeeding work.

The number of pieces in this set would have been greater had their relation to the loess been discovered a little earlier. As it is a number of bones from this layer were included

Fig. 8. Fragment of right lower jaw, with condyle, angle and region of symphysis weathered off, the remaining molar but lightly worn. Found outside of the mound in sector A, see Fig. 5, at a depth of 4½ feet. Specimen No. 4–1–12–06, the Gilder collection, the University of Nebraska. Negative No. 4–1–12–06, the Morrill collection of Geological Photograaphs.

unwittingly in lot No. 7–11–06, and for the sake of accuracy will be left out of account. We will reckon only with those bones which are strictly authentic.

A week later work was resumed, the writer being accompanied

by Mr. Robert F. Gilder and Dr. George E. Condra. All surface material was carefully removed, and three wide shafts were sunk on the northern, eastern, and southern points of the mound. Each shovelful of earth was scrutinized and all bone fragments carefully saved and recorded. In all some twenty bits were found as follows: a fragment from the base of a skull showing the internal occipital protuberance and crest, the superior and inferior cerebellar fossae, and half of the foramen magnum,

Fig. 9. Fragment of a lower jaw, with 4 teeth, anterior and posterior parts weathered off, found in sector B, see Fig. 5, near the circumference, at a depth of 4½ feet, in undisturbed loess. Specimen No. 3–1–12–06, the Gilder collection, the University of Nebraska. Negative No. 3–1–12–06, the Morrill collection of Geological Photographs.

fragments of ribs, limb bones, scapula, and sacrum, a nearly complete clavicle, calcaneum, three complete vertebrae, and two metatarsals.

Some of the parts mentioned are but slivers of human bones, others fragments two or three inches long.

Some were badly etched by water, others gnawed by rodents.

As each fragment was unearthed a block of the matrix was preserved and as far as possible each fragment was preserved in position in the block.

Fig. 10. A water-worn fragment of a lower jaw, imbedded in a block of loess, anterior half with teeth weathered off, found in sector D, see Fig. 5, Specimen No. 1–12–06, the Gilder collection. Negative No. 17–3–1–07, the Morrill collection of Geological Photographs.

This set of bones is numbered 16–11–06 in the catalogue of the University Museum. There are but twenty fragments in this lot, for while it is true that the shafts were sunk to a depth of eight feet, and while bone chips were found at all levels, they were widely

scattered and few in number. Among the fragments may be mentioned five or six bits of skull, as many bits of rib, the angle of a jaw, metatarsal No. 3, and two phalanges. With them were bits of the shell Anodonta, Succinea avara, and several angular pebbles.

Belief that these bones are fossil and synchronous with the loess is strengthened to conviction as work progresses and increasing diligence and accuracy in observation must be exercised. Accordingly when work was again resumed a few days later a circle thirty feet in diameter was described concentrically about the

Fig. 11. Etched fragment of a skull, the pieces of which were scattered over an area 5 by 5 feet, at a depth of 4 to 5 feet.

mound, which has a diameter of 18 feet. The northeast quadrant of the circle was divided into sectors of twenty-two and a half degrees each and lettered. This quadrant was excavated to an average depth of six feet, and its periphery to an average depth of eight to nine feet, and a shaft was sunk twelve feet on the north point.

From one face of this wall an unbroken twelve-foot prism including soil and loess was cut and securely boxed and shipped

for exhibition in connection with the bones. The writer was accompanied in this work by Dr. George E. Condra, by Edwin Davis and Paul Butler, members of the Morrill Geological Expedition of 1906, and as time would permit, by Mr. Gilder.

Systematic work was continued for three consecutive days.

Fig. 12. Fragments of Nebraska Loess Man, from shafts. 1. 2, 3, natural size. See ground plan, Fig. 5.

1, Metatarsal 3, depth 4½ feet, at shaft No. 3.
2, Phalanx, depth 6½ feet, shaft 2.
3, Fragment of rib, depth 5½ feet. shaft 1.
4, Phalanx, depth 7 feet, shaft 1.
5, Fragment of skull, depth 5½ feet, shaft 1.
6, Fragment of rib, depth 5½ feet, shaft 1.
7, Fragment of rib, depth 6½ feet, shaft 1.
8, 9, 10, Fragments of skull, depth 5½ feet, shaft 1.
11, Distal end of rib etched, depth 8 feet, shaft 1.

Fragments of human bones, scattered and unrelated, were found throughout this quadrant at all levels even to a depth of eleven and a half feet.

It was plainly demonstrated that the segment outside of the

mound was quite as rich in bone fragments as that within, and it cannot be maintained that the fragments throughout the loess are necessarily related to the bones in the mound.

The relation of the two sets of bones may be viewed as purely accidental. In but a single instance were several bones found together, namely, three ribs, three or four limb bones, and an

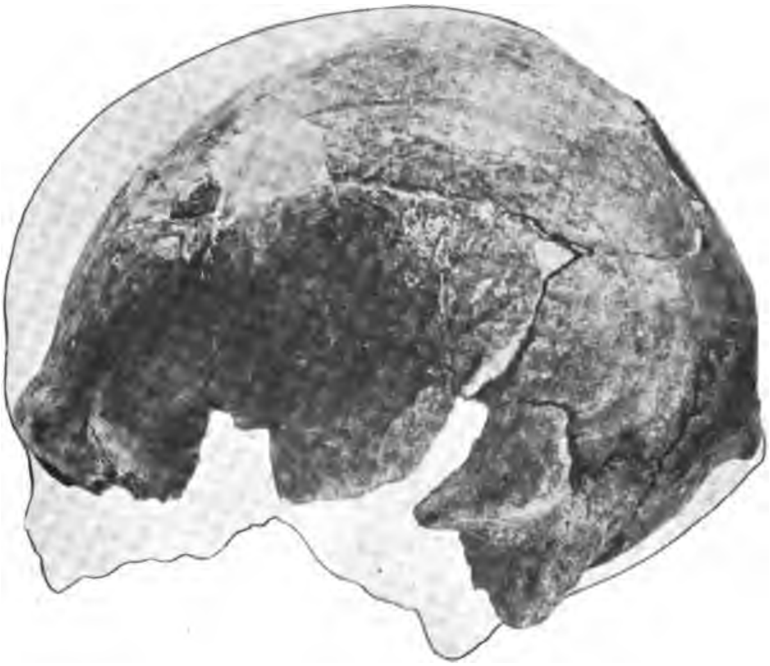

Fig. 13 Skull 8 of Nebraska Loess Man, side view, reduced approximately one-half, and reversed to face left. The tinted outline is that of a European skull. The antero-posterior diameter of skull 8 is 181 mm. Found by C. S. Huntington, 1894, on Long's hill in loess at a depth of 4½ to 5 feet. Specimen No. 3-1-07. Negative No. 30-29-1-07.

astragalas found in proximity. Probably two hundred fragments were exhumed on this occasion, and the set is numbered 1-12-06.

It should be noted that few whole bones were found excepting a few phalanges. Instead they are bone chips and splinters with an occasional section from a limb bone, and many of the

fragments are pitted or etched. Out of this set the following fragments seem of especial interest: half of a jaw with a solitary molar, the condyle, angle and symphysis weathered off, see Fig. 8; fragments of two other unrelated jaws, see Figs. 9, 10, and the

Fig. 14 Top view of the above reduced approximately one-half, and reversed. Negative No. 31-26-1-07. Hon. Charles H. Morrill's collection of geological photographs, The University of Nebraska.

bony palate with the two back molars in place. To those who have collected in the bad lands or in the Loup Fork beds this is strikingly like the conditions there where the deposits are known to be aqueous, as the human-bone bed under consideration is assumed to have been.

By far the most interesting and instructive single specimen found at this time was a skull completely disarticulate, broken, and scattered over a space five by five feet. The skull wall measures as much as nine millimeters or three-eighths of an inch in

thickness. This was taken out in blocks, and, while the reconstruction of a nearly complete skull seems possible, no attempt will be made to remove the bits from their original position, the

Fig. 15 Frontal bone of the above skull, natural size, showing thick protruding brows and retreating forehead without frontal eminences. Negative No. 32-26-1-07 Hon. Charles H. Morrill's collection of geological photographs, University of Nebraska.

intention being to keep everything in such condition as to facilitate the detection of inaccuracies and errors.

The evidence in the case is greatly strengthened by the harmony of testimony from anatomy and geology. The anatomical arguments can be but briefly presented here, since the present paper is concerned with the presentation of geological facts, and a prospective paper dealing with anatomical facts is in preparation.

Suffice it is to say that the skulls are of the Neanderthal type with thick protruding brows, low forehead devoid of frontal eminences, large parietal eminences, narrow temples, thick skull walls, and small brain capacity.

They are higher in the human scale than Neanderthal man, but lower than the mound builder. They resemble the man of Spy.

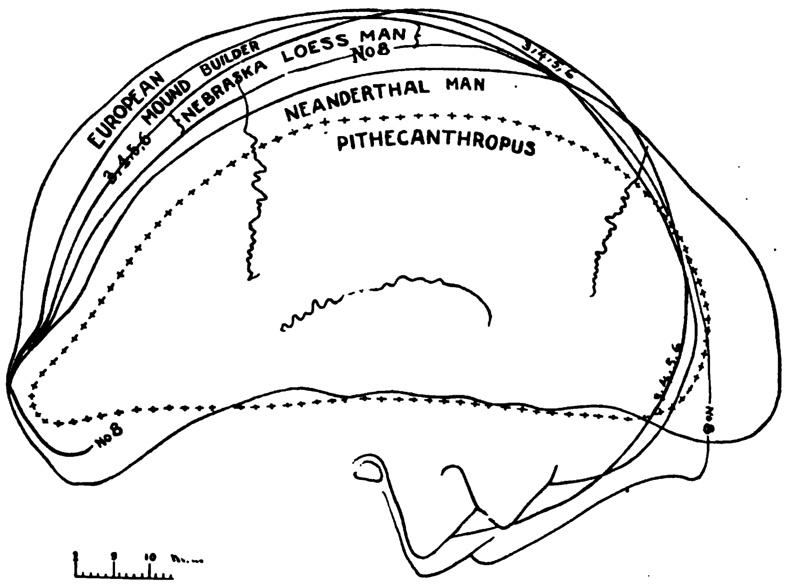

Fig. 16. Outline of various skulls for comparison.

Nos. 3, 4, 5, and 6, a composite outline of the skulls numbered correspondingly.

No. 8 is an outline of the most primitive skull in the collection.

Viewed from above. No. 8 scarcely varies in size from Pithecanthropus.

Drawn from casts and specimens in the museum of the University of Nebraska. One-half natural size.

Measurements: Skull 6, (No. 6-1-11-06) Antero-posterior diameter 181 mm., transverse diameter 145 mm., maximum frontal diameter 114 mm., minimum frontal 93. Owing to the broken condition of the right side the circumference can only be estimated. It is not far from 500 mm., and the height of the skull approxi-

mated for the same reason measures about 125 mm. The cephalic index calculated on the basis of these data is 79. After the mass of fragmentary material has been completely assorted, it is hoped that some skulls may be completed, in which event exact measurements will be possible.

Skull 8 (No. 3-1-07). Skull 8 scarcely varies in size and shape from Pithecanthropus erectus, Antero-posterior diameter 181 mm., transverse diameter 142 mm., maximum frontal diameter 112 mm., minimum frontal diameter 90mm., circumference 500 mm., height of skull 137 mm., cephalic index 78.5 mm.

The foregoing account of work begun is not to be misconstrued as work completed. Investigation must and will be continued for months to come in order to get at the whole truth. The end to be attained is worth the energy to be expended, since everything pertaining to our own species concerns every man.

AGE OF THE SUPPOSED LOESS MAN

The present paper concerns itself simply with the announcement of human remains found in undisturbed loess. Owing to the many factors to be reckoned with the question of age can be discussed intelligently only after continued study. The chief point is that human remains have been found in the loess, as the writer unhesitatingly announces. This, if a fact, as believed, carries man in America back to glacial times. Whether this is the very oldest or newest loess seems a secondary consideration. The loess here is not leached of lime salts, but is actively effervescent at all levels, arguing for recency of deposition.

All recognize the chronological diversity in the loess formation, and whether Long's hill is in the main loess body as the writer believes, or in a much more recent one does not materially affect the relation of the bones to some stage of glaciation, the precise glacial or interglacial age being as yet undetermined. It does not seem to be a secondary loess deposit.

The loess in question rests on Kansan drift, and though as young as the later Wisconsin sheet, or younger even, it is nevertheless old.

In several places adjacent to Gilder's mound exposures of human bones in supposed loess are already known, and investigation promises to extend the present known limits of the supposed human bone bed.

BIBLIOGRAPHY

1. *Preliminary Notice*, World-Herald, Oct. 21, 1906.
By Robert F. Gilder.

2. *Discovery of an early type of man in Nebraska.*
Dated Oct. 24, published in Science, Nov. 16, 1906.
Erwin H. Barbour
Henry B. Ward.

3. *Preliminary Report on the Primitive Man of Nebraska.*
Dated Oct. 26, 1906, published in Nebraska Geological Survey, Vol. II, part 5, pages 219-327, four figures.
Erwin H. Barbour
Henry B. Ward.

4. *Prehistoric Man in Nebraska.*
Dated Oct. 26, 1906, published in Putnam's Magazine, January number, 1907, pages 413-415, 502-503, 3 figures.
Erwin H. Barbour.

5. *A Primitive Human Type in America.*
The Finding of The Nebraska Man.
Published in Putnam's Magazine, January number, 1907, pages 407 to 409, 2 figures.
Robert F. Gilder.

6. *Peculiarities of the Nebraska Man.*
Putnam's Magazine, January number, 1907, pages 410 to 413, 3 figures.
Henry B. Ward.

7. *Discovery of a suppos d Primitive Race in Nebraska.*
Century, January number, 1907, pages 371-375, 7 figures.
Henry F. Osborn.

8. *Evidence of Man in the Loess of Nebraska.*
Dated Dec. 14, 1906. Published in Science, Jan. 18, 1907.
By Erwin H. Barbour.

9. *Evidence of Loess Man in Nebraska.*
Dated Dec. 10, 1906. Nebraska Geological Survey, Vol. II, part 6, pages 229 to 347, 16 figures
Erwin H. Barbour.

10. *Some Ancient Inhabitants of Nebraska.*
Dated Dec. 25, February number, Records of the Past.
Erwin H. Barbour.

The University of Nebraska.
December 20, 1906.

NEBRASKA GEOLOGICAL SURVEY

ERWIN HINCKLEY BARBOUR, STATE GEOLOGIST

VOLUME II

PART 7

REPORT ON THE HONEY CREEK COAL MINE.

BY

ERWIN HINCKLEY BARBOUR

Scientific Contribution

Geological fund of Hon. Charles H. Morrill

LINCOLN, NEB.
WOODRUFF-COLLINS PTG. CO.
1907.

LETTER OF TRANSMITTAL.

To His Excellency, George L. Sheldon,
Governor of the State of Nebraska:

SIR—I have the honor to transmit herewith a preliminary report on the Honey Creek Coal Mine.

Very respectfully,

ERWIN HINCKLEY BARBOUR.

The University of Nebraska,
Department of Geology,
Feb. 19, 1907.

REPORT ON THE HONEY CREEK COAL MINE.

BY ERWIN HINCKLEY BARBOUR.

Prior to 1906 no bed of coal exceeding eighteen inches in thickness had been reported in Nebraska. Black outcroppings on the banks of Honey Creek on the farm of A. M. Borst, four miles southeast of Peru, had long attracted attention, and on February 11, 1906, the work of development began. A bed of coal averaging thirty-four inches in thickness was exposed by Stephen George and Frank Medley, who had leased the ground. The writer immediately visited the mine, made photographs, notes and measurements, and secured samples of coal for analysis.

At that time tunnel No. 1 had been developed some forty feet, and it was apparent that a workable bed of coal had been discovered, and that the claim laid to the outstanding bounty on coal was legitimate. For years past the state Legislature of Nebraska has offered a bounty amounting to $4,000 for the discovery of a twenty-six inch seam of workable coal, and $5,000 for a thirty-six inch seam.

Conditions in the Honey Creek Coal Mine seem favorable, for the coal bed is accessible and readily worked, drainage and ventilation are easily and cheaply provided, and transportation is at hand. As to the quality of the coal, whether good or bad matters little, for any coal is good in a state supposedly destitute of natural fuel. Tests show it to be a good average grade of bituminous coal. Below are analyses of the Honey Creek Coal taken from tunnel No. 1. made by Mr. Leon J. Pepperberg, a Fellow in the Department of Geology, the University of Nebraska. The reader should be reminded that the tests were made of weathered

Fig. 1. The Honey Creek Coal Mine, entrance to tunnel No. 2. One of the proprietors, Mr. Hayes, stands at the right, the other, Mr. George, to the left. A group of miners stand at the entrance. To the right and left is a streak of weathered coal, which leads to a 33 inch bed near the entrance. Negative No. 8-16-2-07. Hon. Charles Morrill's collection of geological photographs, the University of Nebraska.

samples taken from near the surface, thus representing the worst rather than the best of this coal.

	Moisture	Volatile Matter	Coke: Fixed Carbon	Coke: Ash	Total	B. T. U. per pound of Coal	Volatile Matter Per Cent. of Conbustible	Fixed Carbon per cent. of Conbustible
Sample No. I, air-dried .	10.	45 25	36 28	8 47	100	12,621	55.50	44.50
Sample No II, water-soaked as mined	32.22	28 54	19.38	19 86	100	7,492	54 80	45.20
Sample No III, lignitic coal, Cumberland, Wyo., for comparison	3.65	44.27	46.18	5.90	100	14,100	54.90	45.10

Across the Missouri valley in Iowa occurs a similar bed of coal, which doubtless once was continuous with that in Nebraska. Deep borings in regions around but not adjacent to Peru indicate coal seams but a few inches in thickness rapidly pinching out to the westward.

It has certainly been the opinion of geologists at large that commercial coal of great extent was not to be expected in Nebraska, and the occurrence of a workable bed in Peru does not materially change this opinion, for at the best it must be local, being confined to perhaps a township or two, as shown by surrounding deep wells. Though limited to a square mile or so it is of importance to this commonwealth.

While this is spoken of as the first coal mine in the state, it may not be amiss to mention that for a number of years coal has been mined in various places in the southeastern, or carboniferous portion of this state, as at Nebraska City, Rulo, South Fork and elsewhere, but the thickness of coal in each case scarcely equaled eighteen inches, and there was no profit in mining it. The best efforts of a Lincoln company headed by Mr. C. G. Bullock, a man of ability and experience, failed to make the mine at Rulo profitable, and the undertaking, like that of others, was abandoned at the end of two years as unprofitable.

Although considerable amounts of coal were furnished at one time by the South Fork Mine to the neighboring towns, Table

Fig. 2. Honey Creek Coal Mine, tunnel No. 2, showing method of timbering, coal car, track, and three miners. Negative No. 10-16-2-07. Hon. Charles H. Morrill's collection of geological photographs.

Rock, Humboldt, Salem, Dawson and Seneca, the bulk of coal mined thus far has been used by those mining it. Farmers and others often dig out their own supply of winter fuel. A vigorous effort was made to develop a bed, said to be eighteen inches thick, in northeastern Nebraska, it being a lignitic coal in the cretaceous and in no way related to the coal recently discovered. Simultaneously with the discovery of coal at Peru come reports, not yet verified, of a bed equally thick at Falls City.

After tunnel No. 1 had been extended to about 100 feet the interests of Mr. Medley were purchased by Mr. J. K. P. Hayes, and work was begun in earnest under the firm name of Hayes & George. Pursuant to a request by Governor Sheldon, with whom claims had been filed for the bounty offered for the discovery of a workable bed of coal in Nebraska, the writer again visited the spot, February 16, 1907, and the following is a brief report on the present condition of the Honey Creek Coal Mine. Tunnel No. 2 was opened about 50 yards north of tunnel No. 1, and has been extended about three hundred feet into the hill in a southwesterly direction connecting with tunnel No. 1 for the purpose of securing better ventilation. Altogether about three hundred and fifty feet of tunnels have been dug, tracked, and timbered.

Certain large rooms have been dug out, pillars and walls of coal being left to support the roof. From the entrance back thirty to forty feet the coal seam dips five degrees to the east. The rest of the bed seems to be level. The mine being fifteen feet above the level of Honey Creek, drainage is a simple matter. At present an ingeniously designed siphon draws the seepage water from the mine.

The mine can be readily and economically ventilated by drilling holes through the roofing shale, which is about sixty feet thick at tunnel No. 1, and fifty feet thick at tunnel No. 2.

Careful measurements made at a number of points show a homogeneous bed of coal varying from twenty-nine inches to thirty five and a fraction inches in thickness, the average being thirty-three inches.

A number of samples were procured from tunnel No. 2, and a few from No. 1, and will be analyzed and reported upon later in

a special paper by Mr. Roy V. Pepperberg, an assistant in the department of geology, the University of Nebraska.

As heretofore the friendly cooperation of the Department of Chemistry makes such analyses possible without cost to the state.

	Moisture	Totol Combustibles	Ash	Volatile combustible matter	Fixed carbon	Coke-fixed carbon plus ash	Volatile matter per cent of combustible	Fixed carbon per cent of combustible
Honey Creek Mine sample j	26.10	67.20	7.70	36.05	31.15	38.85	58.1	41.9
Honey Creek Mine sample h	26.35	66.50	7.25	32.35	34.15	41.4	47.9	52.1
Webster County Mine, Ia.	14.05	.....	8.34	36.42	41.19	49.53	45.4	54.6
Carlson Mine, Kalo, Iowa	10.1	76.53	13.36	32.83	43.69	57.06	43.3	56.7

Sample j is 25 feet, and sample h is 260 feet back from the entrance of tunnel No. 2. The coal which is lusterless at the entrance becomes bright and lustrous further back in the mine, and the analyses made shows similar improvement.

Fig. 3. View looking east from Mr. William Rader's across Honey Creek valley. To the left through the railroad cut may be seen the Missouri river. Tunnels 1 and 2 are numbered accordingly. At 2 the overlying rock and shale are about 50 feet thick, at 1 about 60 feet, and at the summit of the hill 200 feet. This expanding ridge for a mile or two to the south is known to be underlaid with coal. Compare Fig. 4, Negative No. 2-16-2-07. Hon. Charles H. Morrill's collection of geological photographs, the University of Nebraska.

OUTPUT AND MEN EMPLOYED.

Eight miners are regularly employed and the present output is six to eight tons daily, with a promise of double that capacity soon. The output from the Honey Creek Coal Mine for the first year, that is, from the date of its opening, February 11, 1906, to February 15, 1907, cannot be given exactly, inasmuch as records were not kept until September, 1906. The amount taken

Fig. 4. A general topographic view on Mr. A. M. Borst's place looking north toward William Rader's house (left), and Henry Cole's (right). The valley of the Missouri river may be seen to the right and that of Honey creek to the left. The Honey Creek Coal Mine is at the northern point of the orchard. The hills to the north should be prospected for a similar coal bed. Compare figure 3. Negative No. 5-16-2-07. Hon. Charles H. Morrill's collection of geological photographs, the University of Nebraska.

from tunnel No. 1 is not known, but was probably not less than seventy-five tons. The output is as follows:

	VALUED AT
Feb. 11, 1906, to Aug. 31, 1906, approximately 75 tons	$262.00
September, 1906, coal marketed, 20 tons at $3.50	70.00
October, 1906, coal marketed, 25 tons	87.00
November, 1906, coal marketed, 50 tons	175.00
December, 1906, coal marketed, 70 tons	245.00
January, 1907, coal marketed, 85 tons	298.00
February 1 to 15, 1907, coal marketed, 75 tons	262.00
Total to February 15, 1907, 400 tons	$1,400.00

It should be noted that each month's output shows a marked increase, which presages well. The coal bed is free from nodules

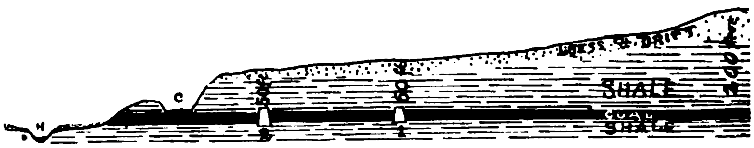

Fig. 5. A geological section running north and south through Honey Creek Coal Mine, showing carboniferous overlaid with drift and loess. C, old railroad cut; H. Honey Creek. Tunnels at 1 and 2.

and interbedding shales. The shale both above and below is compact and holds up well, and is of a light slate color readily distinguishable from the coal, hence the coal shipped is free from waste. The heating quality of this coal from a practical standpoint is very satisfactory, as indicated by the friendly reports of purchasers. This coal has been shipped to Auburn, Brownville, Nemaha City, Peru, and as far west as Republican City, in Harlan county. It has been tested in stoves, furnaces, and boilers. The State Normal School at Peru has been using this coal for months in their large heating plant and they pronounce it good.

According to the terms of the original lease a royalty of fifty cents a ton was to be paid to the lessor on all coal selling for three dollars a ton, and one dollar for coal selling for four dollars. At the present time the royalty has been reduced from fifty to twenty-five cents a ton, and the coal sells for three and a half dollars. When shipped the cost of transpotation is added.

TOPOGRAPHY AND GEOLOGY.

A good idea of the topography of the Honey Creek Coal Mine may be had by comparison of figures 3 and 4.

The region is hilly and broken owing to the proximity of the Missouri river. The property where the coal mine is located has been trenched on the one side by the Missouri, and on the other by Honey Creek, making a narrow ridge pointing to the north. To the south the ridge expands into the neighboring hills, which are also coal bearing as indicated by certain outcroppings.

Farms adjacent to the Borst place may reasonably be expected to yield the same thickness of coal. Just how many acres of coal

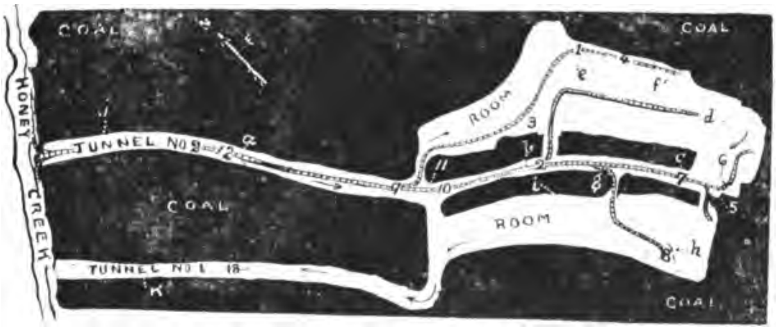

Fig. 6. Sketch map of the Honey Creek Coal Mine. The measurements on page 362 were taken at the points numbered correspondingly. Samples for analysis were taken at the points lettered.

lands there are in this tract is purely a matter of conjecture, since actual tests have not as yet been made. But it is certain there are as promising exposures as that which led to the discovery of the Honey Creek Coal Mine. The hills and valleys in the vicinity supply ample timber for the mine.

Limestones interbedded with shale occur in the vicinity of this coal bed and suggest the possibility of utilizing the coal in the production of hydraulic cement should the amount of coal land prove equal to expectation.

MEASUREMENTS.

Eleven measurements carefully made at various points in tunnel

No. 2 show an average of 33 inches of coal with a minimum thickness of 29¼ inches, and a maximum of 35⅛ inches. At a single spot 36 inches were passed, but the coal being slightlyi nterbedded with shale this measurement is left out of account.

The positions of the measurements is indicated by numerals on the ground plan of the mine.

1.......34	inches	8.......33½	inches
2.......29¼	"	9.......34½	"
3.......29⅜	"	10.......35⅛	"
4.......35	"	11.......31¾	"
5.......31½	"	——	
6.......33½	"	Average, 32.9 inches	
7 31	"		

The writer was accompanied and aided in the verification of observations by Mr. Roy V. Pepperberg, an assistant in the Department of Geology, the University of Nebraska, and by Mr. H. B. Duncanson, professor of geology in Peru State Normal School.

r

c

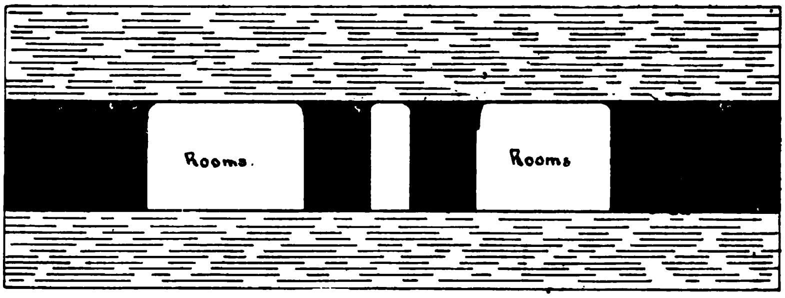

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Fig. 7. Sectional view at Honey Creek Coal Mine, tunnel No. 2, showing room and pillar method of mining. t, tunnel No. 2; r, roofing shale; c, coal bed with a maximum thickness of 35 to 36 inches, a minimum of 29¼ inches and an average of 32.9, or 33 inches in round numbers.

LAW RELATING TO A BOUNTY FOR THE DISCOVERY OF COAL.

CHAPTER 58, COMPILED STATUTES OF NEBRASKA, FOR 1905.

Section 1. [Award for discovery of coal or iron.] That when it shall be made apparent to the Governor of Nebraska, by affidavit or otherwise, by the owner or owners thereof, that a vein of coal not less than twenty-six inches in thickness and of sufficient capacity to pay to mine, and within such distance from the surface that it can be worked by modern methods, has been discovered, or vein or veins of good iron ore eighteen inches thick, it shall be the duty of the Governor to appoint a suitable person to examine the same, whose duty it shall be to report the probable extent and capacity of the vein or veins, all expense for said examination to be paid by the owner or owners of said mine. Said report being satisfactory to the Governor, he shall direct the Auditor to draw an order on the Treasurer for the sum of four thousand dollars, to be paid to the owner or owners of said mine of coal, and of two thousand dollars, to be paid for a vein of iron ore eighteen inches thick. If the vein of coal discovered should be three feet thick and of a required capacity, the sum to be paid shall be five thousand dollars. Said orders to be paid out of the general fund of the state treasury as before provided.

Sec. 4. [Specimen of strata preserved.] It shall be the duty of the persons prospecting for coal, iron ore, crude oil, and gas, carefully to preserve specimens from each stratum through which the shafts are sunk, or borings made, and if the bonus is obtained upon the conditions heretofore mentioned in this bill, to deposit

the same properly labeled, in care of the department of the state for the future use of the commonwealth.

Sec, 5. [Extent of Act.] The provisions of this Act shall not apply to any veins of coal or iron ore already discovered, nor to any oil wells or gas wells already producing, nor shall the provisions of this act apply to the discovery of the same vein of coal or iron ore, or oil pool or gas field already discovered, nor shall any award specified under the terms of this act be paid for a second discovery of the same veins, pools, or fields, within the limit of the same county.

Sec. 6. [Appropriations.] There shall be appropriated out of the funds of the state Treasury, for the purpose of this Act, not already appropriated, the sum of Twenty-five Thousand Dollars.

USEFULNESS OF A STATE BOUNTY.

The offer by the State of a reward for the discovery of coal, oil, gas, iron, etc., is a wise provision of the Legislature, and those connected with the State Geological Survey having been plied by inquires realize what a stimulus to discovery it has been. The fallacious belief is freely indulged in that Nebraska being destitute of natural resources has nothing to develope. Nebraska is not destitute of natural resources. Though less favored in this respect than many states there is the greater reason for encouraging and stimulating the development of such resources as she has.

NEBRASKA
GEOLOGICAL SURVEY

ERWIN HINCKLEY BARBOUR, STATE GEOLOGIST

VOLUME II

PART 8

BIENNIAL REPORT

BY

ERWIN HINCKLEY BARBOUR

WILBER, NEB.
WESTERN PUBLISHING CO.
1907

LETTER OF TRANSMITTAL.

To His Excellency George L. Sheldon,
Governor of the State of Nebraska:

Sir:—I have the honor to transmit herewith a report on the work of the Nebraska Geological Survey for the past biennium, including certain statements respecting the preceding biennium.

ERWIN HINCKLEY BARBOUR,
State Geologist

The University of Nebraska,
Department of Geology,
Lincoln, January, 1907.

BIENNIAL REPORT

BY ERWIN HINCKLEY BARBOUR

WORK OF THE STATE GEOLOGICAL SURVEY IN BRIEF.

The Nebraska Geological Survey as now constituted has been in operation since 1891, but it has enjoyed state aid during the past four years only. Considering the size of the commonwealth and the limited appropriations for geological work, unusual progress has been made. Since no report covering the work of the first biennium was prepared it will be included incidentally in this paper. Briefly stated the Nebraska Geological Survey during the past biennium has devoted especial attention to the industrial resources of the state, prepared ten or twelve reports in manuscript form, published eight reports completing volumes I and II, made extensive collections of industrial material, fitted an office with furniture and fixtures, finished certain maps, many drawings, photographs, and plates for succeeding reports, and has prepared an invoice and catalogué of all survey material.

LIST OF PUBLISHED PAPERS.

VOLUME I, (out of print.)

Report of the State Geologist, pages 1 to 258, 166 figures, 13 plates, 4 colored maps.

By Erwin Hinckley Barbour.

The above report includes a ten-page paper on Jefferson county by F. A. Carmony.

VOLUME II, (not ready for distribution.)

Part 1, The Coal Measure Bryozoa of Nebraska, pages 1 to 168, 1 figure, 21 plates.

By George Evart Condra.

Part 2, The Geology of Cass County, pages 169 to 302, 33 figures, 20 plates, 1 colored map.

By Elmer Grant Woodruff.

Part 3, Notice of a New Fossil Mammal from Sioux county, Nebraska. (The fossil four-horned antelope, Syndyoceras cooki) pages 303 to 311, 1 plate.

By Erwin Hinckley Barbour.

Part 4, Notice of a New Fossil Rhinoceros from Sioux County, pages 311 to 318, 4 figures.

By Erwin Hinckley Barbour.

Part 5, Preliminary Report on the Primitive Man of Ne-

braska, pages 319 to 328, 4 figures.

By Erwin H. Barbour and Henry B. Ward.

Part 6, Evidence of Loess Man in Nebraska, pages 329 to 349, 16 figures.

By Erwin Hinckley Barbour.

Part 7, The Honey Creek Coal Mine, pages 350 to 365, 7 figures.

By Erwin Hinckley Barbour.

Part 8, Biennial Report (the present paper), which concludes Vol. II.

MANUSCRIPT REPORTS.

There are at hand a number of manuscript reports of which the three following are to be published as soon as funds are again available:

1. A paper by Dr. Charles Newton Gould, treating of the clay, sand, and other resources of the Dakota Cretaceous of Nebraska, which will consist of about two hundred pages with numerous illustrations.

2. A paper on cement and its uses and its possible manufacture in Nebraska, by Erwin Hinckley Barbour. The cement industry in the United States is of such rising importance and there is such opportunity for its development in Nebraska that a special paper of two hundred to three hundred pages treating of the subject has been prepared and will be published as soon as the new legislative appropriation is available.

3. A paper on the sand and gravel resources of Nebraska, by Dr. George Evart Condra. Along with the cement industry

comes an increasing demand for Nebraska sand and gravel. The production of these has already attained great proportions and a two hundred page report fully illustrated is now ready and awaiting funds for publication. The foregoing reports were to have been published during the present biennium, and the contract has been let, but owing to the lack of funds, as already explained, they must be held over for a new appropriation.

EQUIPMENT.

Hereafter the legislative appropriation for the Nebraska Geological Survey will go farther for the reason that many of the first expenses of the survey have been met, such as filing cabinets and other necessary office furniture, type-writing machine, maps, drawings, photographs, and engravings. All furniture and equipments are of a plain, substantial, standard sort and will be serviceable for years to come. The regents of the State University have just finished a portion of the first wing of a new fire-proof museum, on the second floor of which will be located the office of the Nebraska Geological Survey.

SALARIES AND ASSISTANTS.

It should be understood that no salaries are paid by the State Geological Survey, the director receiving no compensation of any sort directly or indirectly, and his assistants also contributing their services. The only reward for services thus rendered is the publication of papers prepared by members of the staff giving the results of their labor. Some of these reports have required of the contributors several years of work and even personal outlay. The appropriations are spent in the printing of reports and in the preparation of photographs, drawings, engravings, and other expenses incident to the work of publication. Heretofore the railroads have furnished the members of the geological staff with free transportation while engaged in the investigation of the resources of the state, thus making extensive travel possible. From this time on traveling expenses must of necessity increase,

DEVELOPMENT OF RESOURCES.

During the biennium all industries have flourished, the only lack reported to this office being an insufficient number of laborers. The demand for stone, brick, sand, gravel, lime etc., has exceeded the output. New quarries, sand pits, and clay pits have been opened everywhere.

COAL.

Four miles south of Peru a workable bed of coal, fully 32 inches in thickness, has been opened and is being operated. This mine, known as the Honey Creek Mine, though local, is important and seems destined to rob Nebraska of its old distinction "the state without a mine." A special report with maps, photographs, and coal analyses is ready for publication, and a preliminary report has been made in Vol. II, part 7.

TEST WELLS.

During the year a number of test wells have been drilled in various parts of the state, notably at Beatrice, Lincoln, and Falls City, the object being to determine in each locality whether coal, gas, oil, or artesian water is to be had. Samples and well records are being kept. Such investigations could most commendably and legitimately be made by the state. By right, state appropriation should be granted for this express purpose. At present hundreds of private parties are spending large sums of money each investigating for himself, and no one in particular is getting the benefit. The state could so order and systematize this deep well inquiry that the money of the people would be saved and information for the public obtained.

CEMENT BLOCK.

Great progress is to be reported in the manufacture of cement blocks, posts, paving blocks, etc. Even small towns have

plants for the manufacture of such articles for the local market. Such a plant is almost a necessity in every town, often being run in connection with lumber yards. This industry has been greatly stimulated and developed during the biennium.

SAND-LIME BRICK.

The manufacture of sand-lime brick has begun and one large plant at Hastings is producing and shipping many carloads.

PEAT.

Respecting peat, the demand for information is rapidly increasing, showing a tendency towards the development of this neglected resource. Several peat beds have been located and as soon as titles can be secured these are to be developed. Condensed peat makes a fuel of fine quality, almost as desirable as anthracite itself. It is also an important source of illuminating gas. Samples of such excellent quality have recently been received at the office of the State Survey that belief in the development of this industry is fully warranted. The progress of its development is retarded owing to the reluctance of people in giving information about peat beds. Firms in neighboring states stand ready to come to Nebraska to manufacture peat fuel, and our own citizens are ready to engage in the enterprise. Before the close of another biennium the State Survey will be able to report the development of this industry.

NATURAL PUMICE.

The production of volcanic ash or dust, as it should be called, has been greatly increased, although, for supposed prudential reasons, facts respecting the amount marketed are difficult to obtain. Large amounts are used in various cities for polishing wood, metal, and marble, but more especially in the manufacture of soap and scouring powders. Several carloads have been shipped

to Chicago, as many to the stove works of Detroit, Michigan, to Syracuse, N. Y. to Cincinnati, Ohio, to Denver, Colorado, and in smaller amounts to many other places. Large shipments are being made to South Omaha where scouring soaps of excellent quality are produced.

FLINT.

The flint industry has been well developed and large amounts of flint ballast have been marketed during the past five years. The Atwood company alone has furnished the Burlington railway with 60,000 to 80,000 tons of flint ballast annually for the past four or five years and 50,000 tons for the Rock Island railway between April 20 and December 20, 1906.

CEMENT POSSIBILITIES.

Cement rocks and shale are widely distributed over Nebraska, so the raw material is at hand. The demand in this state for cement productions is increasing by strides. Shipping facilities are ample, so it only remains to develop this very promising natural resource. Already companies have organized in Superior, Beatrice, Lincoln, and several firms outside of the state have expressed their intention of establishing themselves in Nebraska. Before the next biennial report is due it is fully expected that one or more cement mills will be in operation. It may be shown that good cement and plenty of it can be produced for it has been demonstrated practically by the cement mill once in operation at Beatrice, Gage county, Nebraska. The Beatrice cement is known to have been a good article and it should be stated that the old postoffice building in Lincoln, now undergoing repair and renovation for a city hall, has its basement finished in Beatrice cement. It is to be deeply regretted that the mill was abandoned at a time when the state was young, the knowledge of cement and its uses meagre, and the demand for it small. Had it sur-

vived to the present time it might have become a great industry and the re-establishment of this plant is to be greatly desired. There are three distinct cement areas in this state, viz.: the northeastern border or Niobrara region, the southeastern corner or the Carboniferous region, and the southern border of the state or the Republican region. Ten southern counties, viz.: Richardson, Pawnee, Johnson, Sarpy, Douglas, Otoe, Nemaha, Gage, Cass, and parts of Lancaster have exposures of carboniferous shale and limestone theoretically suited to the manufacture of cement. Perhaps it might be explained here that a good cement rock is an impure limestone. If by nature a limestone lacks the right proportions of impurity it can be supplied by adding the right amount of clay or shale. Clay, shales, and limestone occur interbedded throughout this region and are exposed especially in the vicinity of streams; elsewhere they are blanketed over with a great bed of rich soil and are lost to view. The beds of Gage county have been tested in a practical way. The beds at Humboldt have been analysed and tested theoretically and yield good cement. As much can doubtless be said of the other exposures throughout this region. The Niobrara region seems to be a particularly inviting field for the manufacture of cement. Here the chalk and shale of the Benton Cretaceous are associated one above the other and stand exposed in bold bluffs especially at Niobrara, in Knox county.

The location seems to be superior in every way to the same bed at Yankton, where they are producing a good grade of cement. Besides other shipping facilities Niobrara has the additional advantage of wharfage on the Missouri river. The Missouri is navigable to that point and a number of vessels are loaded there with grain for the river trade, hence it is not a remote possibility that cement may be shipped in like manner and discharged at distributing points along the river. The exposures at Niobrara seem to invite especial consideration. Little, if any, stripping is necessary, everything can be handled by

gravitation methods, and the product can be easily distributed. A glance at the map in Volume I will suffice to show the extent and distribution of cement rock in Nebraska. The Republican region also is characterized by exposures of Cretaceous chalk and shale from which cement can be produced as well as at Yankton, and of as good a grade. Superior, where several railroads meet, would make a good producing and distributing point. Some three years ago a company was organized there for manufacturing cement and it is to be hoped that the company has not been disorganized and the undertaking abandoned. Unless one travels extensively he can form little idea of the immense proportions already assumed by the cement industry in the United States. To the credit of the cement workers of the country be it interposed that the quality of American cement has gone up while the price has gone down, and that too in the face of a demand which would have justified most manufacturers in lowering the quality or advancing the price. Immense business houses and warehouses of costly and elegant design are being made of cement, including walls, partitions, floors, and roofs. Such buildings are dust-proof, mouse and insect proof, and fire proof. Engineers count good cement properly laid as better than the best building stone. It is in fact plastic stone which may be moulded and cast to suit each ones needs and taste, and what is particularly commendatory, the amateur can use it. Houses of every grade from the cottage to palatial residences are made of it, irrigating ditches, great cement bridges, dams, and sea walls. For cellars, cisterns, sidewalks, street crossings there is nothing equally good. Its manifold and varied uses extend to the smaller domestic needs and one can see even poultry houses, stock sheds, dog kennels and fruit cupboards made of it. There is no limit to the usefulness of a plastic stone which can be mixed and worked by everyone. In a deforested country, such as the United States is becoming, the demand for cement as a sub-

stitute for lumber must increase in the future even more than in the past and cement plants cannot but multiply.

The Nebraska Geological Survey expects some day to report important development along this line in our state.

CLAY RESOUCES.

Many new brick plants have been added to the list during the biennium, yet they fail to meet the demands made upon them, and many carloads of brick are imported from neighboring states. On every street one finds brick with Des Moines, Iowa, Galesburg, Illinois, or Coffeyville, Kansas stamped in them. May they burn holes in our shoes until we begin to supply our own market. None of these states have better clay or more of it than our own.

QUARRY RESOURCES.

The old quarries and many new ones recently opened were never in a more prosperous condition and all operators consulted speak of their inability to supply the market. The amount of stone needed for buildings, streets, for the process of manufacing beet sugar, and for the smelter at Omaha, is greater than can be supplied at home and large shipments are made, especially from Kansas and Colorado.

SAND RESOURCES.

The increased amount of building in this state, especially extensive concrete work, has taxed to the utmost the sand producers of the state. In spite of steam dredges and improved methods of handling large amounts of sand and gravel, the demand has not been met, and every town has engaged in prospecting for local supplies. The output of sand has become so large and of such growing importance that it is to be treated of in a special paper by Dr. George E. Condra in Volume III of the Nebraska Geological Survey.

RELATION OF THE UNIVERSITY TO THE STATE GEOLOGICAL SURVEY.

The helpful co-operation of the University of Nebraska is and always has been extended to the State Geological Survey. The University furnishes offices and store rooms in fire-proof quarters, cases and microscopes, as well as other apparatus, for examining material, and drawers in which to store specimens, and the force of assistants in the department of geology conduct the work without necessitating the employment of special clerks and helpers. In this and in other ways the State University serves the interest of the State Survey, increasing its efficiency and reducing its expenses.

RELATION OF THE MORRILL GEOLOGICAL EXPEDITION TO THE STATE GEOLOGICAL SURVEY.

Since 1891 the benefactions of Charles H. Morrill of Lincoln have made it possible to explore every corner of the state, thus greatly increasing the efficiency of the State Geological Survey. In this way was made the collection of quarry products, clay, sand, and agricultural soils of the state, in addition to large collections of the fossils of Nebraska which are now numbered by thousands in Mr. Morrill's cabinets. This work has required years of effort and the expenditure of a very considerable sum of money, both of which have been contributed freely to the state, a fact which seems to be generally known and well appreciated. Occasional scientific contributions, describing material secured and facts obtained, are published from the Morrill geological fund.

RELATION OF THE NATIONAL SURVEY TO THE LOCAL SURVEY.

The United States Geological Survey has undertaken to make exact topographic, hydrographic and geologic maps throughout the United States, more especially in those states where financial co-operation is guaranteed. Such work, though indispensable, entails a cost so great as to be simply prohibitory as far as any state survey is concerned.

A considerable amount of work was done in Nebraska a few years ago by the United States Geological Survey without financial co-operation being demanded of this state.

This was done in consideration of the youthfulness of the state and its lack of means at that time. All base maps, photographs, half-tones, and electrotypes of the United States Geological Survey are furnished at cost to the local survey. Likewise in the analysis of soils, coals, water, etc., the local surveys are given the benefit of facts obtained by the National Survey.

PROPOSED GEOLOGICAL SURVEY OF EACH COUNTY.

The United States Geological Survey recognizes no county lines, but lays off the country in definite quadrangles. While it is true that county lines do not constitute a basis of geologic division, they do constitute a geographic division of particular interest to the people. It is the purpose of the State Geological Survey to make a report on each county as rapidly as the work can be done.

Two counties have been surveyed, namely, Jefferson county, by F. A. Carmony, and Cass county, by E. G. Woodruff.

Those counties in which the United States Geological Survey has done topographic work will of necessity be chosen first, because the government maps furnish a base on which to work.

It is the intention of the Nebraska Geological Survey to publish separate reports respecting the resources of each county, including wells, springs, streams and water supply in general, soil, clay, sand, gravel, stone, quarry products and industries, and agricultural and grazing conditions. Each county report is to be accompanied by numerous maps and illustrations.

INVOICE OF THE FURNITURE AND APPARATUS BELONGING TO STATE GEOLOGICAL SURVEY.

1 Remington Standard Typewriting machine, No. 7, machine No. 156,365, Catalogue No. 11-5-05.........$92.25

Large adjustable drawing board, K and E. Cat. No. 15-10-10-05 .... 30.35

1 Surveying rod and target, K. & E. No. 6268, Cat. No. 5-10-10-05 .... 12.75

2 medium drawing boards, K. & E. Cat. Nos. 9-10-10-05.. 9.70

1 steel T square, K. & E, Cat. No. 3-10-10-05........... 5.00

1 brass alidade, K. & E., No. 5218, Cat. No. 14-10-10-05.. 15.00

1 beam compass, K. & E., Cat. No. 7-10-10-05.......... 7.00

1 celluloid triangle and protractor..................... 1.80

1 wooden T square, K. & E., Cat. No. 2-10-10-05........ 2.40

1 hand level, K. & E., No. 5700, Cat. No. 13-10-10-05..... 8.00

Extension rod, K. & E., Cat. No. 10-10-10-05........... 5.00

Steel protractor with arm, K. & E., Cat. No. 6-10-10-05.. 8.00

12 6-inch brass sieves, 6 to 100 mesh, Cat. No. 5-11-05... 24.00

Small balance, Cat. No. 2-5-11-05.................... 3.00

80 glass-stopper show bottles........................ 12.00

2 Y. & E. cases for U. S. Geol. Survey Folios, Cat. No. 25-10-05 .... 84.00

Chest of large drawers for drawings and apparatus, K. & E., Cat. No. 10-10-05 ....35.00

2 Y & E units for blanks and labels, Cat. No. 3-18-1-03.. 15.75

4 Y & E units for card catalogne, Cat. No. 4-18-1-03, 7 and 8 .... 61.00

1 Y & E base, Cat. No. 8 and 9-18-1-03................ 5.00

Set forms for casting cement, Cat. No. 25-6-04.......... 12.00

The above named pieces of furniture and apparatus are so marked as to be readily identified. The catalogue numbers herein given are either stamped in with steel dies or else are painted or stenciled on the pieces of property and varnished over so as not to be effaced.

EXCHANGES.

In exchange for the papers of the Nebraska Geological Survey several hundred books, pamphlets, maps, charts, and public documents have been received.

These are to be properly stamped, catalogued, and recorded when the department is moved into new quarters, and will constitute the beginning of a reference library for the State Survey. This in time will become a valuable asset.

FINANCIAL STATEMENT

1902.

Feb. 3	A. H. Verrill	$25.00
Mar. 17	E. H. Barbour, expenses	36.25
Mar. 26	A. H. Verrill	30.00
April 28	A. H. Verrill	40.00
May 15	J. Manz Engraving Co.	96.00
May 15	U. G. Cornell	115.84
May 20	A. H. Verrill	58.00
Sept. 3	A. H. Verrill	55.00
Sept. 14	E. G. Woodruff	24.53
Sept. 14	Lincoln Plate Glass Supply Co.	32.32
Sept. 28	Jacob North & Co., Vol. I	671.35

1903.

June 15	E. L. Thomas	$23.50
June 15	Norton Ware	9.50
June 15	Helena Redford	42.50
Jan. 22	U. G. Cornell	56.90
Jan. 22	P. J. Harrison	3.75
Jan. 22	G. E. Condra	40.00
July 23	E. H. Barbour, expenses	13.76
July 23	E. L. Webster	50.00
Sept. 14	Helena Redford	15.71
Sept. 28	E. H. Barbour	45.80
Sept. 28	H. I. Redford	18.50
Oct. 20	E. G. Woodruff	12.00
Oct. 20	U. G. Cornell Engraving Co.	9.74
Dec. 8	Helena Redford	18.00
Dec. 8	F. W. Heath	2.50
Dec. 8	E. G. Woodruff	9.50
Dec. 8	E. H. Barbour, expenses	4.43

1904.

Jan.	16	Helena Redford	28.50
Jan.	16	Albert Jacobson	40.00
Jan.	27	U. G. Cornell	2.92
Jan.	27	U. G. Cornell	9.15
Feb.	17	Harry Porter	140.50
Feb.	26	Helena Redford	20.00
Feb.	26	E. H. Barbour	5.25
Ma.r	9	E. L. Webster	5.25
Mar.	9	Helena Redford	11.13
Mar.	9	Lincoln Marble and Granite Works	12.50
Mar.	25	Frank Loomis	3.00
Mar.	25	Linn Huntington	4.05
April	18	Clara Edholm	10.71
April	18	E. G. Woodruff	10.50
April	18	J. B. Davidson	18.00
April	18	Review Press	5.00
April	28	G. E. Condra	6.71
May	6	Hammond Printing Co.	218.68
May	13	Hammond Printing Co.	36.15
June	14	Cornell Engraving Co.	23.56
June	25	J. Thorp & Co.	12.85
Aug.	3	Harry Porter	7.75
Aug.	15	Cornell Engraving Co.	30.97
Sept.	15	Helena Redford	32.40
Oct.	5	A. O. Wiggenjost	6.80
Oct.	22	Albert Jacobson	5.00
Oct.	22	Cornell Engraving Co.	12.32
Oct.	22	Cornell Engraving Co.	5.40
Oct.	22	Helena Redford	7.50
Nov.	14	Kimball Bros.	7.60
Nov.	14	Cornell Engraving Co.	10.91
Dec.	12	Globe Delivery Co.	3.25
Dec.	20	Helena Redford	5.55
Dec.	29	Harry Shedd	13.50

1905.

Jan.	2	Lincoln Photo Supply Co.	3.20
Jan.	22	E. L. Webster	54.30

Feb.	23	Lincoln Photo Supply Co.	11.68
Feb.	23	U. G. Cornell	14.75
Mar.	11	E. L. Webster	30.30
Mar.	11	A. O. Wiggenjost	2.50
Mar.	18	E. H. Barbour, expenses	5.25
Mar.	27	Cornell Engraving Co.	29.84
April	12	Cornell Engraving Co.	7.15
May	3	A. O. Wiggenjost	6.91
May	10	E. L. Webster	49.95
Mar	12	Remington Typewriter Co.	92.25
June	7	E. L. Webster	26.16
June	19	A. O. Wiggenjost	2.75
June	19	M. R. Barbour	10.25
July	15	E. L. Webster	54.60
July	19	Margaret Harrington	1.70
Aug.	1	S. Fred Prince	5.00
Aug.	4	Cornell Engraving Co.	50.63
Aug.	4	E. L. Webster	35.10
Aug.	23	Harry Porter	139.06
Sept.	9	Lincoln Photo Supply Co.	12.90
Aug.	26	Harry Porter	42.00
Sept.	9	C. A. Barbour	105.00
Sept.	12	E. L. Webster	38.40
Sept.	12	U. G. Carnell Engraving Co.	98.63
Sept.	12	B. L. Melick	36.00
Sept.	12	Harry Porter	3.00
Sept.	12	E. H. Barbour, expenses	37.43
Sept.	12	Woodruff-Collins Printing Co.	24.25
Oct.	4	B. L. Melick	55.56
Oct.	4	E. L. Webster	25.10
Oct.	27	M. R. Barbour	18.50
Nov.	11	H. M. Eakin	8.70
Nov.	16	Riehle Bros.	20.10
Nov.	28	Cornell Engraving Co.	6.60
Dec.	21	G. E. Condra	9.45

1906.

Jan.	3	Cornell Engraving Co.	18.05
Jan.	10	Rudge & Guenzel	3.00

Jan.	13	E. L. Webster	59.25
Jan.	17	Riehle Bros.	17.25
Jan.	25	Nebraska Paper & Bag Co.	9.63
Jan.	25	Woodruff-Collins Co.	21.25
Feb.	21	A. L. Beekley	1.25
Mar.	13	Helena Redford	13.25
Mar.	13	E. L. Webster	18.30
Mar.	13	H. M. Eakin	34.00
April	10	H. M. Eakin	20.25
April	10	E. L. Webster	51.30
April	14	Cornell Engraving Co.	49.46
May	19	Lincoln Drug Co.	12.00
May	22	Roy V. Pepperberg	10.20
June	4	Swedish-American Publishing Co.	207.20
June	4	H. M. Eakin	22.75
June	30	Nebraska Survey	13.00
July	6	E. L. Webster	69.45
July	6	B. L. Melick	27.75
July	10	Remington Typewriter Co.	11.50
July	10	E. H. Barbour, expenses	6.33
July	19	G. E. Condra	7.60
July	28	Cornell Engraving Co.	50.18
Aug.	16	E. L. Webster	39.30
Sept.	18	M. R. Barbour	7.00
Sept.	25	Cornell Engraving Co.	37.86
Oct.	1	Edna Mentor	21.00
Dec.	20	E. F. Schramm	6.20
Dec.	29	Freight bills	7.10

1907.

Feb.	14	E. H. Barbour, freight bills	2.66
Feb.	14	Cornell Engraving Co. for Oct., Nov., Dec., Jan.	69.89

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